



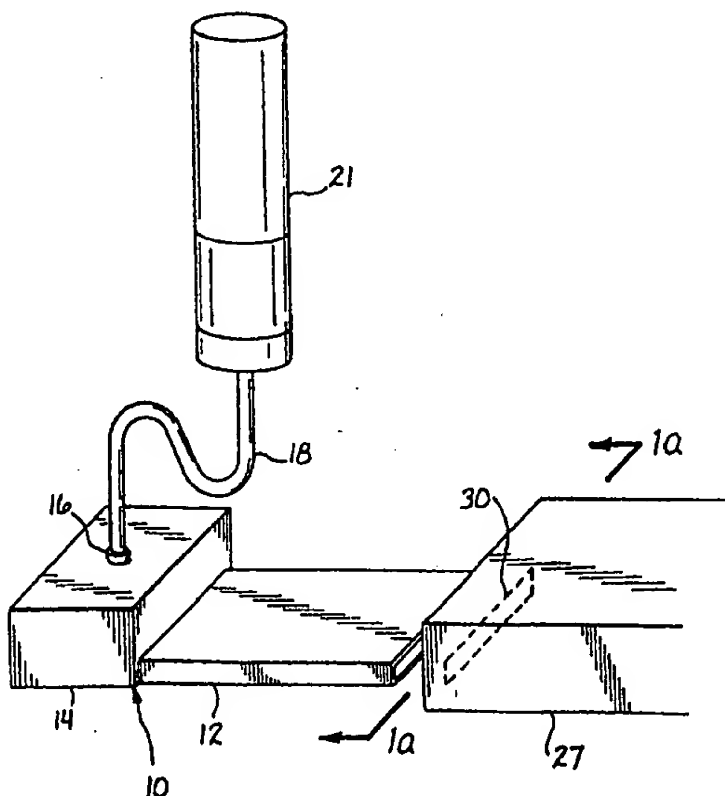
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: PERSONAL COMPUTER CARD FOR COLLECTION OF REAL-TIME BIOLOGICAL DATA

## (57) Abstract

A real time biological data processing PC card (10) is lightweight, cost effective, and portable. The real time biological data processing PC card is capable of converting a host personal computer system (27) into a powerful diagnostic instrument. Each real time biological data processing PC card is adapted to input, and process biological data from one or more biological data sensors (21). It is interchangeable with other real time biological data processing PC cards. A practitioner having three different real time biological data processing PC cards, for example, each one corresponding to a different biological data collection device, effectively carries three full sized, powerful diagnostic instruments. The full resources of a host personal computer can be utilized, and converted into a powerful diagnostic instrument, for each biological data collection device, by the insertion of one of the real time biological data processing PC cards.



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PERSONAL COMPUTER CARD FOR COLLECTION OF  
REAL-TIME BIOLOGICAL DATA

This application is a continuation-in-part of U.S. Application Serial No. 08/810,632, entitled PERSONAL COMPUTER CARD FOR COLLECTION OF REAL-TIME BIOLOGICAL DATA, which is commonly assigned and the contents of which are expressly incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to personal computer (PC) cards and, more particularly, to PC cards for use in combination with personal computers for  
5 collecting biological data on a real-time basis.

2. Description of Related Art

The United States health care system is currently in the midst of a transformation away from specialized  
10 medicine toward a more cost-conscious, primary-care oriented system. Devices having cost-effective means for diagnosing and monitoring patients are expected to gain prominence in the market place. Many current data acquisition devices exist in the medical industry, but  
15 few, if any, of these devices are economical, extremely lightweight and portable, accurate, versatile, and interchangeable with other biological data collection devices.

One prior art device, manufactured by the assignee  
20 of the present application, incorporates a diagnostic box which is adapted to interface with a serial port of a personal computer. This diagnostic box is manufactured with a relatively expensive housing, having

a size approximately equal to that of a book, an alternating current (AC) chord and power adapter, a serial port cable, a microprocessor, and other hardware elements.

5           The diagnostic box allows a user to perform real-time spirometry operations, while harnessing the PC computer's display, keyboard, printer, and other items. The PC computer display instructs the user with  
10           selectable patient incentives, and user-customized reports can be generated. The display of the personal computer can be configured to display volume-versus-time and flow-versus-volume curves. Additionally, parameters such as maximum exhale volume, maximum inhale volume and  
15           maximum flow rate can be computed and displayed on the personal computer display.

          Data acquisition cards have existed in the prior art for transferring electrical signals from a data sensor through the data acquisition card and into a personal computer. These data acquisitions cards have  
20           been configured into Personal Computer Memory Card International Association (PCMCIA) cards.

          Prior art data acquisition cards are often configured to measure potential signals ranging from zero to ten volts, and are often configured with twelve  
25           bit accuracy. A typical prior art data acquisition card may comprise a 30 pin connector and a cable, which is connected to a connector board. The connector board allows a user to hook up various signals thereto. In addition to the relatively high-voltage signal range  
30           (zero to ten volts), low-accuracy (e.g. twelve bits), extra hardware (30 pin connector, cable, and a connector board), and additional optional hardware, these prior art data acquisition cards are configured with a  
35           plurality of inputs and outputs and, further, are not adapted to convert a personal computer into a powerful

biological data signal collecting, processing, and monitoring system.

Prior art data acquisition cards are not adapted for performing spirometry collection and analysis, since these cards are not equipped with pressure transducers for converting pressure signals into electrical signals. Even if these prior art data acquisition cards were equipped with pressure transducers, the cards would not be equipped with high-precision low-voltage signal collection and conditioning circuitry. A prior art data acquisition card, additionally, would not be suitable for other biological data collection and processing purposes, such as Electrocardiography (ECG) biological data collection, since these prior art data acquisition cards are not equipped with any insulating means for insulating a patient from potential shock, which may be delivered from the data acquisition card to the patient.

Another prior art device is disclosed in U.S. Patent Number 5,549,115 to Morgan et al. The Morgan et al. patent generally discloses a PCMCIA format card which is adapted to perform as a data storage device, similarly to a floppy disc storage device. The PCMCIA format card of Morgan et al. is equipped with a real-time clock for providing time and date data to the host system, in order to synchronize the host system time with the time of which the data was actually acquired. The PCMCIA format card of Morgan et al. does not provide any means for real-time data collection and processing and, accordingly, is not suitable for converting a host PC computer into a real-time biological data signal collection, processing, and monitoring system. The system of the Morgan et al. patent requires a separate dedicated computer device for acquiring the data, and a separate personal computer device for processing the data at a later time.

U.S. Patent Number 5,546,432 to Thomson discloses a spirometer which includes control electronics located remotely from a hand-held housing. Communication between the hand-held housing, which includes an analog-to-digital (A/D) converter and an amplifier, occurs through a cable. A dedicated microprocessor including a simple keyboard structured and adapted specifically to control the operation of a spirometer is included in the Thomson device. The handle-shaped housing of the Thomson patent is quite different from a PC card.

A need exists in the prior art for real-time biological data signal collecting, processing, and monitoring systems, which are extremely lightweight and portable. The prior art has not introduced any cost-effective PC card, which is adapted to convert a host personal computer into any of a variety of real-time data collecting and processing systems.

#### SUMMARY OF THE INVENTION

The real-time biological data processing PC card of the present invention is very lightweight, cost effective, and portable. The real-time biological data processing PC card of the present invention is capable of converting a host personal computer system into a powerful diagnostic instrument. Each real-time biological data processing PC card is adapted to input and process biological data from one or more biological data sensors, and is interchangeable with other real-time biological data processing PC cards. A practitioner having three different real-time biological data processing PC cards, each one corresponding to a different biological data collection device, effectively carries three full-sized, powerful diagnostic instruments. The full resources of a host personal computer may be utilized and converted into a powerful

diagnostic instrument, for each biological data collection device, by the insertion of one of the real-time biological data processing PC cards.

5 A portable computer card for collecting biological data, according to the present invention, includes a pressure transducer adapted to receive an air pressure from an air tube and to convert the air pressure into an electrical signal. The portable computer card includes an analog-to-digital converter adapted to receive and  
10 digitize the electrical signal, and a portable computer card interface adapted to provide an interface between the portable computer card and a host microprocessor system. The portable computer card interface may comprise a PCMCIA card interface. An amplifier, which  
15 is adapted to receive and amplify the electrical signal from the pressure transducer, is disposed between the pressure transducer and the analog-to-digital converter. The amplified electrical signal is related to the air pressure. The portable computer card further includes a  
20 housing, which is adapted for holding the pressure transducer, the amplifier, the analog-to-digital converter, and the portable computer card interface. A pressure input port is disposed on the housing. This pressure input port is in fluid communication with the  
25 pressure transducer and is adapted to receive an air pressure from an air tube. The portable computer card further includes a flexible air passageway, which is integrally connected to the housing, and which is adapted to supply an air pressure to the pressure input  
30 port.

According to still another aspect of the present invention, a portable biological data collection device includes a portable computer card housing, a biological data receiver, signal conditioning circuitry, and a  
35 portable computer card interface. The biological data

receiver is adapted to receive biological data and to output the biological data, and the signal conditioning circuitry is adapted to receive the biological data from the biological data receiver and to convert the  
5 biological data into digitized biological data. The portable computer card interface is disposed within the portable computer card housing, and is adapted to communicate with a host computer to relay the digitized biological data to the host computer on a real-time  
10 basis as the biological data is converted by the signal conditioning circuitry.

The biological data receiver can be adapted to receive biological data from a pulse oximetry sensor, which is located externally of the portable biological  
15 data collection device. The biological data receiver can further be adapted to receive biological data from an ECG sensor. The biological data sensor is adapted to output low-amplitude signals on an order of one millivolt. The digitized data from the analog-to-  
20 digital converter preferably has a resolution greater than 12 bits and, preferably, has a resolution of 16 bits. The biological data sensor may further include a spirometer air tube.

According to another aspect of the present  
25 invention, a host computer is configurable among a plurality of biological data collection device modes. The host computer includes a portable computer card slot adapted to receive a portable computer card therein, a portable computer card interface adapted to communicate  
30 with a portable computer card inserted into the portable computer card slot, a microprocessor, a data bus, and input means for receiving designation data from a portable computer card within the portable computer card slot. The portable computer card interface is adapted  
35 to receive digitized biological data from a portable



computer card inserted into the portable computer card slot, and the input means is operatively connected to the microprocessor. The designation data is indicative of a type of digitized biological data from a portable computer card inserted into the portable computer card slot. The designation data may comprise either a first identifier for indicating that the digitized biological data should be interpreted by the microprocessor as spirometer-pressure data or a second identifier indicating that the digitized biological data should be interpreted by the microprocessor as pulse oximetry electrical data. The host computer includes configuration means for configuring the host computer into a real-time spirometer-pressure data collecting and analyzing device upon receipt of the first identifier, and for configuring the host computer into a real-time pulse oximetry electrical data collecting and analyzing device upon receipt of the second identifier. The host computer may also be configured into an ECG data collection device mode, upon receipt of a third identifier from the input means. Additionally, the host computer may be configured among various other biological data collection device modes, upon receipt of additional identifiers.

According to yet another aspect of the present invention, a combination of a plurality of interchangeable biological data portable computer cards includes a spirometer portable computer card and a pulse oximetry portable computer card. The spirometer portable computer card and the pulse oximetry portable computer card are both insertable into a personal computer system, and are interchangeable. The spirometer portable computer card is adapted to convert the host computer into a spirometer data collecting and analyzing device, and the pulse oximetry portable

computer card is adapted to convert the host computer into a pulse oximetry data collecting and analyzing device. The combination of interchangeable biological data portable computer cards may further include an ECG portable card, as well as other computer cards, each being adapted to convert the host personal computer into a different type of biological data collecting and analyzing device.

According to another aspect of the present invention, a portable computer card for delivering biological data to a host computer includes a portable computer card housing, at least one conductor connected to the portable computer card housing, an amplifier operatively connected to the at least one conductor, a power source operatively connected to the amplifier, and insulating means for providing electrical insulation between the power source and the conductor. The conductor is adapted to collect biological data from a patient, and the amplifier is adapted to receive the biological data and to output an amplified signal. The insulating means may comprise an optical translator, and can be positioned between the conductor and the amplifier. The portable computer card further includes an analog-to-digital converter for digitizing the amplified signal, and a portable computer card interface for providing a communication link between the portable computer card and a host personal computer system. The portable computer card interface is adapted to relay the digitized amplified signal to the host computer on a real-time basis, as biological data is collected from a patient. The power source comprises a conductor, which is adapted for receiving power from the host personal computer.

The present invention, together with additional features and advantages thereof, may best be understood

by reference to the following description taken in connection with the accompanying illustrative drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

5 Figure 1 illustrates a real-time biological data processing PC card according to the present invention;

Figure 1a illustrates an end view of the real-time biological data processing PC card of Figure 1, taken from the direction of the line 1a-1a;

10 Figure 1b illustrates a top planar view of the real-time biological data processing PC card, without the air tube connection;

Figure 2 illustrates a schematic block diagram of the circuitry of the real-time biological data processing PC card and a host personal computer system, according to the present invention;

Figure 3 illustrates a host-personal computer system according to the present invention;

Figure 4 illustrates a real-time biological data processing PC card according to the present invention;

20 Figure 5 illustrates a schematic block diagram of the circuitry of the real-time biological data processing PC card according to the present invention;

Figure 6a illustrates a simplified perspective view of the main circuit board of the real-time biological data processing PC card according to the present invention;

Figure 6b illustrates a pulse oximeter module circuit board according to the present invention;

30 Figure 7 illustrates an articulated finger clip sensor according to the present invention;

Figure 8 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis vitals data;

Figure 9 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis ventilator-operation data;

5        Figure 10 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis sleep-disorder related data;

10       Figure 11 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis ECG data; and

15       Figure 12 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis carbon-dioxide detection data;

20       Figure 13 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis hydrogen detection data;

Figure 14 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis alcohol detection data;

25       Figure 15 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis sleep-disorder related data including body motion and position and ECG;

30       Figure 16 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis sleep-disorder related data including body motion and position, ECG, EOG and EMG;

Figure 17 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis blood pressure related data;

5        Figure 18 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis birth procedure related data;

10       Figure 19 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis blood glucose detection data;

15       Figure 20 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis blood cholesterol detection data;

20       Figure 21 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis blood arterial-blood-gas detection data;

Figure 22 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis oxygen detection data;

25       Figure 23 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis body composition data;

30       Figure 24 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis heart beat data;

Figure 25 illustrates a schematic block diagram of a real-time biological data processing PC card for

collecting and forwarding on a real-time basis ear-drum pressure data;

Figure 26 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis blood flow related data;

Figure 27 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis EEG related data;

Figure 28 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis biological data to a game set; and

Figure 29 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis biological data to a set-top box.

#### DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

Turning to Figure 1, a real-time biological data processing PC card 10 is illustrated having a Personal Computer Memory Card International Association (PCMCIA) format housing 12 and a pressure transducer housing 14. The pressure transducer housing 14 preferably comprises a pressure input port 16, which is adapted to removably accommodate a flexible air passageway 18. A disposable spirometry mouthpiece 21 is attached to one end of the flexible air passageway 18, and a connector is attached to the other end of the flexible air passageway 18. As presently embodied, the connector comprises a truncated, conical shape which is adapted for matingly fitting within the pressure input port 16. After a user breaths into the disposable spirometry mouthpiece 21, the

flexible air passageway 18 and the disposable spirometry mouthpiece 21 may be removed from the pressure input port 16, and discarded. In the below description and claims, the term "spirometry" is intended to encompass not only the general meaning of the word, but also to broadly encompass any other pulmonary function which can be detected by measuring air flow, pressure or volume.

The PCMCIA format housing 12 of the real-time biological data processing PC card 10 is preferably configured to conform with PCMCIA dimensional standards. As presently preferred, the PCMCIA format housing has a width of approximately 2.95 inches. The PCMCIA format housing 12 preferably comprises a length of approximately 3.40 inches. The pressure transducer housing 14, according to the presently preferred embodiment, has dimensions which are larger than PCMCIA conventions permit. As presently embodied, the pressure transducer housing 14 comprises a height of approximately 1 inch. These enlarged dimensions of the pressure transducer housing 14 facilitate placement of biological sensor circuitry, such as, for example, a pressure transducer.

Figure 1a illustrates an end view of the real-time biological data processing PC card 10, taken from a view along the line 1a-1a of Figure 1, and Figure 1b illustrates a top-planar view of the real-time biological data processing PC card 10. A host personal computer 27 comprises a PCMCIA format slot 30, which is sized and dimensioned according to PCMCIA dimensional standards, in order to facilitate insertion of the PCMCIA format housing 12 therein.

Figure 2 illustrates a schematic block diagram of components associated with the real-time biological data processing PC card 10 and the host personal computer 27. The real-time biological data processing PC card 10

comprises a pressure sensor 32, an amplifier 34, an analog-to-digital converter 36, an analog-to-digital timing circuit 38, a storage buffer 41, and a PCMCIA interface 43. The flexible air passageway 18 connects the disposable spirometry mouthpiece 21 to the pressure sensor 32, and a conductor path 45 connects the pressure sensor 32 to the amplifier 34. The amplifier 34 is connected to the analog-to-digital converter 36 via a conductor path 47, and the analog-to-digital converter 36 is connected to the storage buffer 41 via a conductor path 50. A conductor path 52 connects the analog-to-digital converter 36 to the analog-to-digital timing circuit 38, and a conductor path 54 connects the analog-to-digital timing circuit 38 to the PCMCIA interface 43. The storage buffer 41 is connected to the PCMCIA interface 43 via a conductor path 51. Upon insertion of the real-time biological data processing PC card 10 into the PCMCIA format slot 30, the PCMCIA interface 43 is connected to a PCMCIA bus interface 58 via a bus 61.

The host personal computer 27 comprises a microprocessor 61, a storage 63, a display 65, a keyboard 67, and a PCMCIA interface 70. The host personal computer 27, of course, may comprise other components which are not shown in Figure 2. The microprocessor 61 is connected to the storage 63 via a bus 72, and is connected to the keyboard 67 via a bus 74. A bus 76 connects the display 65 to the bus 74, and a bus 78 connects the display 65 to the keyboard 67. The microprocessor 61 is connected to the PCMCIA interface 70 via a bus 81, and the PCMCIA interface 70 is connected to the PCMCIA bus interface 58 via a bus 83.

When the real-time biological data processing PC card 10 and the host personal computer 27 are configured as shown in Figure 2, communication between the devices



10 and 27 can occur via standardized PCMCIA protocols. The PCMCIA Developer's Guide - 2nd Edition, published by Sycard Technology in 1994, the contents of which are expressly incorporated herein by reference, discloses information on PCMCIA conventions and protocols.

Although the embodiment of Figure 2 is shown comprising a pressure sensor 32 and a disposable spirometry mouthpiece 21, any biological data sensor and/or associated components may be incorporated into the real-time biological data processing PC card 10 in accordance with the present invention.

In one embodiment, each biological data sensor, having a different format of biological data, is configured in a separate real-time biological data processing PC card. The various real-time biological data processing PC cards are interchangeable, to thereby configure the host personal computer 27 into various real-time biological data collecting and processing modes. Alternatively, a single real-time biological data processing PC card 10 may be configured to accommodate one or more different types of biological data sensors. According to the present invention, various interchangeable real-time biological data processing PC cards can configure the host personal computer 27 into various collecting, processing, and monitoring modes, including spirometry, electrocardiography (including resting, 24-hour, stress testing, signal averaging, event ECG, and heart-rate variability), blood pressure, body temperature, electroencephalography (EEG), echocardiography, Doppler, pulse oximetry (SP02), sleep analysis, tcPO2, tcPCO2, nitrogen dioxide, capnography, respiratory rate, pulse rate, polysomnography, carbon monoxide, gastroesophageal pH, hydrogen, nitric oxide, bio-impedance, glucometer, audiometry, plethysmograph, weight, electromyography,

urometry, and tympanometry, for example. The term "bio-impedance" is intended to include the general meaning of the term "bio-impedance" and to also include body composition analysis, cardiac output or any other bio-impedance analysis. Other biological data may also be collected and processed by the host personal computer 27, after being configured by a corresponding real-time biological data processing PC card.

The real-time biological data processing PC card 10 shown in Figure 2, which is adapted for configuring the host personal computer 27 for spirometry procedures, receives a pressure signal from the mouth piece 21. The pressure sensor 32, which preferably comprises a pressure transducer, converts the pressure signal into an electrical signal, which is amplified by the amplifier 34. The analog-to-digital converter 36, which is timed by the analog-to-digital timing circuit 38, receives the amplified biological data from the amplifier 34, and digitizes the biological data. The analog-to-digital timing circuit 38 provides a timing signal, which facilitates sampling of the amplified biological data on the conductor path 47. This digitized biological data is output onto the conductor path 50. The storage buffer 41 receives the digitized biological data, and outputs this digitized biological data onto a conductor path 51, where the digitized biological data is made available to the PCMCIA interface 43. The storage buffer 41 preferably comprises a first in first out (FIFO) buffer, and may be omitted for simple configurations where buffering capabilities are not needed. The real-time biological data processing PC card 10 further comprises control circuitry, and the PCMCIA interface 43 preferably comprises input output (I/O) interface glue logic and an input output connector.

Upon insertion of the real-time biological data processing PC card 10 into the PCMCIA format slot 30 of the host computer 27, the microprocessor 61, the PCMCIA interface 70 of the host computer 27, and the PCMCIA interface 43 of the real-time biological data processing PC card 10 begin communicating via established PCMCIA format conventions. The microprocessor 61 determines the type of real-time biological data processing PC card which has been inserted into the PCMCIA format slot 30. In the illustrated case of Figure 2, designation data from the PCMCIA interface 43 indicates to the microprocessor 61 that a spirometry-type real-time biological data processing PC card 10 has been inserted. Designation data from the PCMCIA interface 43 may, alternatively, identify the real-time biological data processing PC card 10 as being adapted for relaying oximetry, ECG, or other biological data to the host personal computer 27. As an alternative to, or in addition to, the illustrated embodiment of Figure 2, a user may input designation data via the keyboard 67 or the display 65, indicating the type of real-time biological data processing PC card 10 which has been inserted into the PCMCIA format slot 30 of the host personal computer 27.

After the host personal computer 27 has "set up" the real-time biological data processing PC card 10, the host personal computer 27 prompts, via the display 65, the user to begin the spirometry test. As presently embodied, multi-media devices, such as entertaining displays and sounds, are implemented by the host personal computer 27 in order to educate the patient on how to perform the biological data test. The display 65 prompts the patient to begin the test, and coaches the patient during the test with, for example, entertaining incentives. This multi-media instructional system is

configured to assist patients, especially in home disease management situations, helping asthmatics and cystic fibrosis patients, for example, comply with testing protocols. Additionally, the system of the present invention may reduce the need for skilled human interaction in order to achieve successful administration of the biological data tests.

The biological data from the pressure sensor 32, after being processed by the amplifier 34 and the analog-to-digital converter 36, is preferably immediately transferred from the PCMCIA interface 43 of the real-time biological data processing PC card 10 to the PCMCIA interface 70 of the host personal computer 27. The host personal computer 27, having received designation data indicating that the real-time biological data processing PC card 10 is a spirometry real-time biological data processing PC card, is configured to function as a complete spirometry data collecting, processing, and monitoring device. For example, a volume-versus-time wave form or a flow-versus-volume curve may be displayed on the display 65, indicating the real-time biological data received by the pressure sensor 32. A number of other parameters, such as maximum exhale volume, maximum inhale volume, and maximum flow rate, to name a few, may also be shown on the display 65 of the host personal computer 27. This data also may be compiled and printed in a variety of analytical and comparative formats.

Figure 3 illustrates a host personal computer 27, according to the presently preferred embodiment. The host personal computer 27 preferably comprises a Personal Digital Assistant (PDA). The host personal computer 27 may comprise any desktop or laptop computer, as well. When the host personal computer 27 comprises a personal digital assistant, as presently preferred,

Windows® CE (Pegasus) software is preferably used. This software preferably operates on the Windows® CE operating system. Other commercially available software packages, or customized software packages, may be used with the present invention. A pointing device 87, held by the hand 90 of a user, may be used to input data into the host personal computer 27 via a touch sensitive display 65. The host personal computer 27, having the real-time biological data processing PC card 10 of Figure 1 inserted therein, is configured into a powerful diagnostic spirometry data collecting and analyzing instrument. Since the real-time biological data processing PC card 10 uses the keyboard 67, display 65, storage 63, microprocessor 61, power supply (not shown), and data transmission and printing capabilities (not shown) of the host computer system 27, the real-time biological data processing PC card 10 itself is very inexpensive and rudimentary in design. Yet, the real-time biological data processing PC card 10 is very powerful. The software loaded within the host personal computer 27 is preferably configured to allow the real-time biological data processing PC card 10 to interface, via PCMCIA format, with any other of a variety of personal computers, such as a desktop personal computer, or a notebook personal computer, for example.

The host personal computer 27 can transmit data via any conventional means, such as a serial port cable or a modem connection through an RJ11 phone plug. Data may be transmitted over the Internet, for example. In home disease management, for example, the host personal computer 27 can be configured to gather, process, and transmit additional information on the patient's medication, diet, symptoms, and other parameters. The combination of elements of the present invention thus

provides a very portable, lightweight, and inexpensive means for diagnosing and monitoring patients.

Figure 4 illustrates a real-time biological data processing PC card 10, having both a disposable spirometry mouthpiece 21 and a pulse oximeter finger clip 98. Like components are designated with like reference numbers. As with the embodiment of Figure 1, the disposable spirometry mouthpiece 21 is connected to pressure transducer housing 14 via a flexible air passageway 18 and a pressure input port 16. The pulse oximeter finger clip 98 is connected to the pressure transducer housing 14 via a pulse oximeter cable 101, which transitions into a connector 103.

Figure 5 illustrates a schematic block diagram of an embodiment of Figure 4. Basically, data from a pulse oximeter sensor 105, such as the pulse oximeter clip 98 (Figure 4), is fed to a pulse oximeter module 107 via a conductor path 110. As presently embodied, an optical coupler is positioned between the pulse oximeter finger clip 98 and a power source (not shown) connection of the real-time biological data processing PC card 10, to thereby prevent a patient from being shocked therefrom. Data from the pulse oximeter module 107 is then fed to the PCMCIA interface 43 via a conductor path 112. The pulse oximeter module 107 preferably comprises elements similar to the amplifier 34, the analog-to-digital converter 36, the analog-to-digital timing circuit 38, and the storage buffer 41. The elements of the pulse oximeter module 107 may be combined with or into the elements 34, 36, 38, 41 or, as presently embodied, maintained separately therefrom in the pulse oximeter module 107.

The host personal computer 27 may receive on a real-time basis, process, and monitor spirometry data and pulse oximetry data, either separately or

simultaneously. The designation data, in the illustrated embodiment, indicates to the host personal computer 27 that the real-time biological data processing PC card 10 comprises both spirometry data and pulse oximetry data sensors. The pressure sensor 32 may alternatively be located on the disposable spirometry mouthpiece 21, as can the amplifier 34, the analog-to-digital converter 36, and the analog-to-digital timing circuitry 38, or any combination thereof. Any or all of these elements, in addition to the storage buffer 41, may be positioned on either the disposable spirometry mouthpiece 21, the pulse oximeter sensor 105, or the real-time biological data processing PC card 10, or any combination thereof, or eliminated altogether. Since the present invention is not intended to be limited to PCMCIA interfaces 43, any circuitry capable of forwarding an analog signal to a host personal computer 27 could reduce the need for components within the real-time biological data processing PC card 10. The pulse oximeter sensor 105 and the pulse oximeter module 107 may be manufactured by Nonin® Medical, Inc., located in Plymouth, Minnesota. According to one embodiment, the pulse oximeter sensor 105 may be similar that in an 8600 portable pulse oximeter, manufactured by Nonin® Medical, Inc.

Figure 6a illustrates the main circuit board 118 of the presently preferred embodiment, generally corresponding to the elements 32-54 of Figure 5. The main circuit board 118 is illustrated comprising a number of IC chips 121, a pressure input port 16, and a pressure sensor 32. A pulse oximetry module connector 125 accommodates a pulse oximetry module connector 127, which is illustrated in Figure 6b. The pulse oximetry module connector 127 of Figure 6b is electrically connected to a supplemental circuit board 130. The

supplemental circuit board 130 generally corresponds to the pulse oximeter module 107 of Figure 5.

Figure 7 illustrates a perspective view of a pulse oximeter finger clip 98 connected to a hand 87 of a user. The pulse oximeter finger clip 98 is connected to the supplemental circuit board 130 via a pulse oximeter cable 101.

Figure 8 illustrates a schematic block diagram of a real-time biological data processing PC card 10a for collecting and forwarding on a real-time basis vitals data. In the embodiment of Figure 8, like elements are designated with like reference numerals followed by the letter "a.". Data from a pulse oximeter sensor 105a is fed to a pulse oximeter module 107a via a conductor path 110a. As presently embodied, an optical coupler is positioned between a pulse oximeter finger clip (not shown) and a power source (not shown) connection of the real-time biological data processing PC card 10a, to thereby prevent a patient from being shocked therefrom. Data from the pulse oximeter module 107a is then fed to the PCMCIA interface 43a via a conductor path 112a. The pulse oximeter module 107a may comprise conventional circuitry for processing data from the pulse oximeter sensor 105a, such as elements including an amplifier, an analog-to-digital converter, an analog-to-digital timing circuit, and a storage buffer. The elements of the pulse oximeter module 107a may be combined with or into the elements of the temperature module 201 and the blood pressure module 203 or, as presently embodied, maintained separately therefrom in the pulse oximeter module 107a.

Data from a temperature sensor 205, indicating a body temperature of a patient, is fed to the temperature module 201 via a conductor path 207. Data from the temperature module 201 is then fed to the PCMCIA



interface 43a via a conductor path 209. The temperature module 201 may comprise conventional circuitry for processing data from the temperature sensor 205, such as elements including an amplifier, an analog-to-digital converter, an analog-to-digital timing circuit, and a storage buffer. The elements of the temperature module 201 may be combined with or into the elements of the pulse oximeter module 107a and/or the elements of the blood pressure module 203 or, as presently embodied, maintained separately therefrom in the temperature module 201.

Data from a blood pressure sensor 211, indicating a blood pressure of a patient, is fed to the blood pressure module 203 via a conductor path 213. Data from the blood pressure module 203 is then fed to the PCMCIA interface 43a via a conductor path 215. The blood pressure sensor 211 preferably comprises a cuff with microphones as is known in the art. The blood pressure module 203 may comprise conventional circuitry for processing data from the blood pressure sensor 211, such as elements including an amplifier, an analog-to-digital converter, an analog-to-digital timing circuit, and a storage buffer. The elements of the blood pressure module 203 may be combined with or into the elements of the pulse oximeter module 107a and/or the elements of the temperature module 201 or, as presently embodied, maintained separately therefrom in the blood pressure module 203.

As presently embodied, a host personal computer 27 receives on a real-time basis, processes, and monitors pulse oximetry data, body temperature data, and blood pressure data either separately, sequentially, or simultaneously. The designation data, in the presently preferred embodiment, indicates to the host personal computer 27 that the real-time biological data

processing PC card 10a comprises pulse oximetry data, temperature data and blood pressure data sensors. One or more of the components comprising the pulse oximeter module 107a, the temperature module 201 and/or the blood pressure module 203 may alternatively be located on the  
5        respective sensors 105a, 205, 211.

Turning to Figure 9, a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis  
10        ventilator operation data is shown. In the embodiment of Figure 9, like elements are designated with like reference numerals followed by the letter "b." A pressure line 220 and flow line 222 are connected to monitor pressure and flow rate of a ventilator connected  
15        to a patient. The pressure line inputs pressure data from a hose of the ventilator to a pressure sensor 224 and, subsequently, to an amplifier 226. The flow line 222 are input into the pressure sensors 228 and the amplifier 230. An analog-to-digital converter 232  
20        receives the signals from the amplifiers 226 and 230, and converts the signals to digital signals. The digital signals are forwarded to the PCMCIA interface 43b via a storage buffer 236.

The host personal computer 27 receives on a real-time basis, processes and monitors the pressure and flow rate data from the sensors 220 and 222 either  
25        separately, sequentially or simultaneously. The designation data indicates to the host personal computer 27 that the real-time biological data processing PC card  
30        10b comprises pressure and flow rate data from a ventilator hose connected to a patient. One or more of the components of the PC card may be placed on the pressure line 220 or the differential flow line 222.

Figure 10 illustrates a schematic block diagram of a real-time biological data processing PC card for  
35

collecting and forwarding on a real-time basis, sleep-disorder related data. A chest band 240 is placed around a patient's chest to measure the patient's respiration rate, for example. Sensors on the chest band 240 measure movement of the patient's chest while the patient is sleeping for determining, for example, whether the patient is breathing through his or her nose and whether an obstruction is present. Data from sensors on the chest band 240 is input into a strain gauge 242 and subsequently amplified by an amplifier 244. A nasal canula/thermistor 246 measures breathing through a patient's nose, and the data therefrom is input into a pressure sensor 248 and subsequently amplified by the amplifier 250. A pulse oximetry sensor 253 measures the patient's pulse rate and/or blood-oxygen concentration. Data from the chest band 240 and the nasal canula/thermistor 246 is digitized by the analog-to-digital converter 260 and passed to the PCMCIA interface 43c via a storage buffer 263. Data from the pulse oximetry sensor 253 is similarly passed to the PCMCIA interface 43c after being processed by an oximetry module 266. The data from the chest band 240, the nasal canula/thermistor 246 and the pulse oximetry sensor 253 is transferred to the host personal computer 27 on a real-time basis, either separately, sequentially or simultaneously.

Figure 11 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis ECG data. One to twelve leads 275 are attached to a patient for inputting ECG data to a defibrillator protector 277. The defibrillator protector 277 accommodates operation of the PC card 10d when the patient is defibrillated, as is known in the art. Conventional noise reduction 279 and isolation 281 components receive data from the

preamp 283. Data from the isolation circuitry 281 is input to a filter and analog-to-digital conversion module 293 via an amplifier 295. The ECG data is input into a PCMCIA interface 43d via a storage buffer 297.

5 The noise reducer 279 may comprise, for example, a driven right leg and driven shield configuration, wherein an ECG signal from the leads 275 is inverted and injected back into the patient's right leg to cancel noise. The driven shield comprises a similar mechanism  
10 for reducing noise as is known in the art.

The PC card 10d may be configured to implement a signal averaging mode of ECG data collection, wherein a relatively high sampling rate of 2,000 to 3,000 samples per second is implemented, for example. The samples are  
15 subsequently averaged for providing additional resolution, compared to a slower sampling rate such as 250 samples per second. Moreover, instead of implementing one to twelve leads for feeding electrical signals from the patient to the PC card 10d, a wireless  
20 embodiment may be implemented. In this embodiment, electrical signals from the patient are transmitted to a receiver on a PC card, for example. Processed data from the twelve leads 275 is transferred from the PC card 10d to the host personal computer 27 on a real-time basis in  
25 accordance with the present invention.

Turning to Figure 12, a PC card 10e for collecting and forwarding on a real-time basis carbon dioxide detection data to a host personal computer 27 on a real-time basis is disclosed. Carbon dioxide in the breath  
30 of a patient is detected by a carbon dioxide detection module 312, after being input through a mouthpiece 314. Figure 13 illustrates a hydrogen detection module 317 within a PC card 10f. A patient breathes into a mouthpiece 319. A reading on a detected amount of  
35 hydrogen is forwarded to the PC card 27 via a PCMCIA

interface 43f of the PC card 10f on a real-time basis. As shown in Figure 14, a real-time biological data processing PC card 10g collects breath from a user via a mouthpiece 322. An amount of alcohol in the user's  
5 breath is detected by an alcohol detection module 324, which sends digital data to the PCMCIA interface 43g for subsequent routing on a real-time basis to the personal computer 27.

10 A real-time biological data processing PC card for collecting and forwarding on a real-time basis sleep-disorder related data including body motion and position, and ECG, is shown in Figure 15. The apnea card circuitry generally corresponds to that disclosed in Figure 10, and the PC card 10h further comprises a  
15 microphone module 326 for receiving sound signals from a microphone 328 and forwarding digitized signals on a real-time basis to the PCMCIA interface 43h. A limb motion module 331 inputs data from motion sensors 333. Data from the motion sensor or sensors 333 is processed  
20 by the limb motion module 331 and forwarded on a real-time basis to the PCMCIA interface 43h. Position data from a position sensor 336 is forwarded to the body position module 338, processed, and subsequently forwarded on a real-time basis to the PCMCIA interface  
25 43h. The microphone 328 can be attached to a neck of a patient, for example, for providing information as to whether the patient is snoring. The motion sensor 333 may comprise an accelerometer, for example, and may be attached to a limb of a patient to determine limb and/or  
30 body motion. The position sensor 336 may comprise a mercury switch, for example, and may be attached to a portion of a patient to determine whether the patient is lying on his or her stomach or back, for example. An ECG sensor 341 may comprise one or two channels, for  
35 example, for inputting electrical information to the ECG

module 343. Processed information from the ECG module 343 is subsequently forwarded on a real-time basis to the PCMCIA interface 43h.

5 The PC card 10i of Figure 16 is similar to that depicted in Figure 15, with additional EEG, EOG, and EMG components. An EEG sensor 348, an EOG sensor 350 and an EMG sensor 352 forward signals detected on a patient to an EEG module 354, an EOG module 356, and an EMG module 358, respectively, on a real-time basis. The EEG module 10 354, the EOG module 356 and the EMG module 358 forward processed data to the PCMCIA interface 43i on a real-time basis and, subsequently, as with the other embodiments of the present invention, the PCMCIA interface 43i preferably forwards the real-time data to 15 the host personal computer 27 on a real-time basis.

Turning to Figure 17, a real-time biological data processing PC card 10j inputs blood pressure data from a blood pressure sensor 370 on a real-time basis. The blood pressure sensor preferably comprises a blood 20 pressure cuff with microphones. A blood pressure module 372 receives the data from the sensor 370 and forwards processed digitized data on a real-time basis to the PCMCIA interface 43j.

Figure 18 illustrates a real-time biological data 25 processing PC card for collecting and forwarding on a real-time basis birth procedure related data. A chest band 380 comprises a contraction sensor 382 and a fetus heart rate sensor 384. The contraction sensor 382 may comprises a pressure sensor, for example, which is 30 adapted to be disposed on a woman's stomach via the chest band 380, and the fetus heart rate sensor 384 may comprise a microphone. An additional sensor (not shown) may also be incorporated for monitoring on a real-time basis the mother's heart rate. The additional sensor 35 may comprise, for example, a pulse oximeter. Data from

the contraction sensor 382 and the fetus heart rate sensor 384 is input into the pressure sensors and amplifiers 386, 388, 390, 392. An analog-to-digital converter 394 processes the information and outputs the information to the PCMCIA interface 43k via a storage buffer 397.

Figures 19, 20, and 21 illustrate non-invasive blood composition detection PC cards 10L, 10m and 10n, respectively, for collecting on a real-time basis biological data and forwarding the data on a real-time basis to a host personal computer 27. The blood glucose module 401 of the PC card 10L inputs blood glucose data from a non-invasive blood glucose sensor 403 on a real-time basis. The non-invasive blood glucose sensor 403 may comprise any conventional means for measuring a blood glucose concentration of a patient, such as, for example, a patch adapted to be attached to a person's skin or an optical measuring apparatus. A blood cholesterol module 406 of the PC card 10m (Figure 20) inputs blood cholesterol data from a non-invasive blood cholesterol sensor 408. The non-invasive blood cholesterol sensor 408 may comprise any non-invasive blood-cholesterol measuring apparatus. The detection module 411 (Figure 21) of the PC card 10n is adapted to receive a breath of a patient via a mouthpiece 413, and detect on a real-time basis gases including, oxygen, carbon dioxide, nitrogen and/or carbon monoxide. Each of the modules 401, 406 and 411 forwards processed sensor data on a real-time basis to the PCMCIA interfaces 43L, 43m and 43n, respectively. Figure 22 illustrates a PC card 10o comprising an oxygen detector 415 for inputting breath from a mouthpiece 417 and forwarding processed data on a real-time basis to a PCMCIA interface 43o.

A real-time biological data processing PC card 10p for collecting and forwarding on a real-time basis body composition data is illustrated in Figure 23. A first conductor 422 and a second conductor 424 provide  
5 electrical resistance data on a real-time basis to the current source/electrical resistance module 426, which subsequently forwards processed information to the PCMCIA interface 43p. The current source/electrical  
10 resistance detection module 426 in a preferred embodiment injects an electrical signal into a patient via the first conductor 422, and uses the second detector 424 to determine an electrical resistance of the patient. In modified embodiments, either the  
15 current source, the electrical resistance detector, or both, may be disposed within the host personal computer 27. Based upon the measured electrical resistance and the electrical signal injected into the patient, an estimate of a fat composition of the patient is generated and forwarded to the PCMCIA interface 43p on a  
20 real-time basis.

The PC card 10q illustrated in Figure 24 collects heartbeat information on a real-time basis from a heartbeat sensor 430. The heartbeat information is processed via an amplifier 434 and an analog-to-digital  
25 converter 436, and is passed on a real-time basis to the PCMCIA interface 43q via a storage buffer 438. The real-time heartbeat data can be monitored and manipulated on the personal computer 27.

The PC card 10r of Figure 25 inputs data on a real-  
30 time basis from an ear probe 440 into a pressure sensor module 443, which processes the data and subsequently outputs the processed data to the PCMCIA interface 43r on a real-time basis. The ear probe 440 may comprise a hand-held wand for placement into the ear of a patient.  
35 The hand-held wand may comprise mechanical means for



measuring the eardrum pressure or, alternatively, may comprise optical means for measuring an eardrum pressure of the patient as is well known in the art.

Turning to Figure 26, a PC card 10s inputs data  
5 from a pencil probe 450 into a Doppler shift blood flow detection module 455 on a real-time basis. The pencil probe 450 emits acoustical signals which are used for measuring blood flow as is known in the art.  
Information from the pencil probe 450 is first processed  
10 by the Doppler shift blood flow detection module 455, and is subsequently forwarded on a real-time basis to the PCMCIA interface 43s for use by the personal computer 27. The PC card 10t in Figure 27 inputs  
electrical information from EEG sensors 460 into an EEG  
15 module 465 on a real-time basis. The EEG module 465 processes the electrical data and outputs the processed data to a PCMCIA interface 43t on a real-time basis for use by the personal computer 27.

Figure 28 illustrates a real-time biological data  
20 processing PC card 501 connected to a game set 503 for collecting and forwarding on a real-time basis biological data to the game set 503. The biological data is received on a real-time basis into the PC card 501 from one or more sensors 505 and 507. A game  
25 control 509 is connected to the game set 503, and a television 511 operates as a monitor. The PC card 501 can be configured similarly to any of the above-described PC cards of the present invention, with an exception of the interface for communicating with the  
30 game set 503. The game set 503 may comprise a game set such as Nintendo® or Sega®. If the game set 503 has a Windows CE operating system and a PCMCIA card slot, then the PC card 501 may be virtually identical to any of the above-discussed PC cards of the present invention. If  
35 the game set 503 does not have a PC card slot, then

other housing and/or interfaces may be implemented with the PC card 501 to facilitate proper real-time communication between the PC card 501 and the game set 503. One example, compact flash cards and compact flash card housings may be used. As another example, proprietary Nintendo® game set digital interfaces may be used with the PC card 501. The game console 509 may be connected to either the game set 503 or the television 511, and may be linked by a conventional cord or by a wireless communication path.

Figure 29 illustrates a real-time biological data processing PC card 521 for collecting and forwarding on a real-time basis biological data to a set-top box 523. The set-top box 523 is connected to a television 525, which operates as a monitor, and is further connected to a keyboard 527. The keyboard 527 may be connected to either the set-top box 523 or the television 525 via a conventional cable or a wireless communication path. In accordance with the illustrated embodiment, the set-top box 523 comprises an Internet connection 532 for facilitating real-time data transfer of biological data from the sensors 535, 537 to one or more receivers on the Internet. The PC card 521 and sensors 535, 537 may comprise any combination of PC cards and sensors discussed in any of the above embodiments. The set-top box 523 can transmit biological data from the sensors 535, 537 on a real-time basis over the Internet to other users, such as a user at a doctor's office or hospital. Additionally, the set-top box 523 can receive biological data on a real-time basis from other users via the Internet connection 532. Information received from other users via the Internet connection 532 can be displayed by the set-top box 523 on the television 525, for example.

Information can be transmitted and received through the Internet connection 532 either on a real-time basis or, alternatively, at predetermined intervals. The set-top box 523 may be configured to automatically dial out and establish an Internet connection, and to transmit or receive real-time biological data over the Internet, at predetermined or user-defined intervals. A patient can conduct tests using one or more sensors, such as the sensors 535 and 537, and at the same time or at a later time, transmit the data to a doctor via the Internet connection 532. In addition to a set-top box 523, Internet telephones, personal computers, wireless Internet computers, network computers or other Internet "appliances" capable of sending real-time data over the Internet may be used. In one embodiment, game sets may be used to transmit or receive the real-time biological data over the Internet.

In modified configurations of the above-described embodiments, some or all of the circuitry and/or components for each of the modules on the personal computer cards can be placed within the host microprocessor system, so long as the card is able to input digital information to the host microprocessor system. Moreover, in other modified configurations circuitry and/or components for each of the modules on the personal computer cards can be placed on the biological data sensors themselves, in addition to or in the alternative to placement of the circuitry and/or components on the host microprocessor system. In embodiments where the signal or signals from the biological data sensor or sensors is simply digitized and forwarded to the host microprocessor system (personal computer, game set, set-top box, etc.) for subsequent processing and interpretation, the signal-conditioning circuitry can comprise the

bare-essential elements, such as merely an analog-to-digital converter, for formatting the data from the biological data sensors and forwarding to the host microprocessor system.

5           In embodiments wherein the host microprocessor system comprises a game set, for example, the personal computer card may have additional initializing data. This may be the case for embodiments wherein other types of host microprocessor systems are used, as well. In  
10       some embodiments, the host microprocessor system is loaded with initializing data and instructions, for example, before the personal computer card is loaded into the host microprocessor system. In other  
15       embodiments, substantial amounts of data and/or instructions are loaded into the host microprocessor system (or game set, set-top box, etc.) by the personal computer card at the time of insertion of the personal computer card into the host microprocessor system.

          In any of the above-described embodiments of the  
20       present invention, the personal computer card may comprise a PCMCIA-type card, a card having an interface which is adapted to communicate with a game set, a compact flash card, or any other type of portable card with an interface for transmitting data to a host  
25       microprocessor system. An example of a host microprocessor system adapted for accommodating compact flash cards is the Cassiopeia E-10, manufactured by Casio Computer Co. Ltd and described at  
      <http://www.casiohpc.com/index.html>.

30       Although exemplary embodiments of the invention have been shown and described, many other changes, modifications and substitutions, in addition to those set forth in the above paragraphs, may be made by one having ordinary skill in the art without necessarily

departing from the spirit and scope of the present invention.

CLAIMS:

1. A portable biological data collection device,  
comprising:

at least one biological data receiver for inputting  
biological data;

5 signal-conditioning circuitry operatively coupled  
to the at least one biological data receiver, the  
signal-conditioning circuitry comprising at least one  
analog-to-digital converter  
and being adapted to output at least one digital signal;  
10 and

a digital interface operatively coupled to the  
signal-conditioning  
circuitry, the digital interface being adapted to  
interface the portable biological data collection device  
15 to a host microprocessor system.

2. The portable biological data collection device  
as recited in Claim 1, wherein the digital interface  
comprises a compact flash card interface, the compact  
flash card interface being adapted to communicate with  
5 the host microprocessor system and to relay the at least  
one digital signal to the host microprocessor system on  
a real-time basis as the signal conditioning circuitry  
outputs the at least one digital signal.

3. The portable biological data collection device  
as recited in Claim 1, wherein the digital interface  
comprises a game-set card interface, the game-set card  
interface being adapted to communicate with a game-set  
5 host microprocessor system and to relay the at least one  
digital signal to the game-set host microprocessor  
system on a real-time basis as the signal conditioning  
circuitry outputs the at least one digital signal.

4. A personal computer card for collecting biological data, comprising:

a pulse-oximetry signal receiver, the pulse-oximetry signal receiver being adapted to receive  
5 a pulse-oximetry signal from a pulse-oximetry sensor and further being adapted to output the pulse-oximetry signal;

a blood-pressure signal receiver, the blood-pressure signal receiver being adapted to receive  
10 a blood-pressure signal from a blood-pressure sensor and further being adapted to output the blood-pressure signal;

a temperature signal receiver, the temperature signal receiver being adapted to receive a  
15 body-temperature signal from a body-temperature sensor and further being adapted to output the body-temperature signal;

signal-conditioning circuitry operatively coupled to at least one of the pulse-oximetry signal receiver, the blood-pressure signal receiver and the temperature  
20 signal receiver, the signal-conditioning circuitry comprising at least one analog-to-digital converter and being adapted to output at least one digital signal; and

a personal computer card interface operatively  
25 coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

5. The personal computer card as set forth in Claim 4, wherein the personal computer card interface is adapted to relay the at least one digital signal to the

5 host microprocessor system on a real-time basis as the  
at least one digital signal is output by the  
signal-conditioning circuitry.

6. The personal computer card as set forth in  
Claim 4, wherein:

the personal computer card comprises a personal  
computer card housing;

5 the pulse-oximetry signal receiver is coupled to  
the personal computer card housing;

the blood-pressure signal receiver is coupled to  
the personal computer card housing;

10 the temperature signal receiver is coupled to the  
personal computer card housing;

the signal-conditioning circuitry is operatively  
coupled to at least one of the pulse-oximetry signal  
receiver, the blood-pressure signal receiver and the  
temperature signal receiver; and

15 the personal computer card interface is disposed  
within the personal computer card housing.

7. The personal computer card as set forth in  
Claim 4, wherein:

5 the pulse-oximetry sensor is coupled to the  
pulse-oximetry signal receiver, the pulse-oximetry  
sensor being adapted to be placed into close proximity  
with a patient, to output a pulse-oximetry signal and to  
relay the pulse-oximetry signal to the pulse-oximetry  
signal receiver;

10 the blood-pressure sensor is coupled to the  
blood-pressure signal receiver, the blood-pressure  
sensor being adapted to be placed into close proximity  
with a patient, to output a blood-pressure signal and to  
relay the blood-pressure signal to the blood-pressure  
data receiver;



15           the body-temperature sensor is coupled to the  
temperature signal receiver, the body-temperature sensor  
being adapted to be placed into close proximity with a  
patient, to output a body-temperature signal and to  
20           relay the body-temperature signal to the temperature  
signal receiver.

8.   A personal computer card for collecting  
biological data, comprising:

          a temperature signal receiver, the temperature  
signal receiver being adapted to receive a  
5           body-temperature signal from a body-temperature sensor  
and further being adapted to output the body-temperature  
signal;

          signal-conditioning circuitry operatively coupled  
to the temperature signal receiver, the  
10           signal-conditioning circuitry being adapted to receive  
the body-temperature signal from the temperature signal  
receiver and to convert the body-temperature signal into  
digitized body-temperature data; and

          a personal computer card interface operatively  
15           coupled to the signal-conditioning circuitry, the  
personal computer card interface being adapted to  
provide an interface between the personal computer card  
and a host microprocessor system.

9.   The personal computer card as set forth in  
Claim 8, wherein the personal computer card interface is  
adapted to relay the digitized body-temperature data to  
the host computer on a real-time basis as the  
5           body-temperature signal is converted by the signal  
conditioning circuitry.

10.   The personal computer card as set forth in  
Claim 8, wherein:

the personal computer card comprises a personal computer card housing;

5 the temperature signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the temperature signal receiver; and

10 the personal computer card interface is disposed within the personal computer card housing.

11. The personal computer card as set forth in Claim 8, wherein the body-temperature sensor is coupled to the temperature signal receiver, the body-temperature sensor being adapted to be placed into close proximity  
5 with a patient, to output a body-temperature signal and to relay the body-temperature signal to the body-temperature receiver.

12. A personal computer card for collecting biological data, comprising:

a blood-pressure signal receiver, the blood-pressure signal receiver being adapted to receive  
5 a blood-pressure signal from a blood-pressure sensor and further being adapted to output the blood-pressure signal;

signal-conditioning circuitry operatively coupled to the blood-pressure signal receiver, the  
10 signal-conditioning circuitry being adapted to receive the blood-pressure signal from the blood-pressure signal receiver and to convert the blood-pressure signal into digitized blood-pressure data; and

a personal computer card interface operatively  
15 coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

13. The personal computer card as set forth in Claim 12, wherein the personal computer card interface is adapted to relay the digitized blood-pressure data to the host computer on a real-time basis as the  
5 blood-pressure signal is converted by the signal conditioning circuitry.

14. The personal computer card as set forth in Claim 12, wherein:  
the personal computer card comprises a personal computer card housing;  
5 the blood-pressure signal receiver is coupled to the personal computer card housing;  
the signal-conditioning circuitry is operatively coupled to the blood-pressure signal receiver; and  
the personal computer card interface is disposed  
10 within the personal computer card housing.

15. The personal computer card as set forth in Claim 12, wherein the blood-pressure data sensor is coupled to the blood-pressure signal receiver, the blood-pressure data sensor being adapted to be placed  
5 into close proximity with a patient, to output a blood-pressure signal and to relay the blood-pressure signal to the blood-pressure receiver.

16. A personal computer card for collecting biological data, comprising:  
a differential flow signal receiver, the differential flow signal receiver being adapted to  
5 receive a differential flow signal from a differential flow sensor and further being adapted to output the differential flow signal;

10 a line pressure signal receiver, the line pressure signal receiver being adapted to receive a line pressure signal from a line pressure sensor and further being adapted to output the line pressure signal;

15 signal-conditioning circuitry operatively coupled to at least one of the differential flow signal receiver and the line pressure signal receiver, the signal-conditioning circuitry comprising at least one analog-to-digital converter and being adapted to output at least one digital signal; and

20 a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

17. The personal computer card as set forth in Claim 16, wherein the personal computer card interface is adapted to relay the at least one digital signal to the host microprocessor system on a real-time basis as the at least one digital signal is output by the  
5 signal-conditioning circuitry.

18. The personal computer card as set forth in Claim 16, wherein:

the personal computer card comprises a personal computer card housing;

5 the flow signal receiver is coupled to the personal computer card housing;

the line pressure signal receiver is coupled to the personal computer card housing;

10 the signal-conditioning circuitry is operatively coupled to at least one of the flow signal receiver and the line pressure signal receiver; and

the personal computer card interface is disposed within the personal computer card housing.

19. The personal computer card as set forth in Claim 16, wherein:

5 the flow sensor is coupled to the flow signal receiver, the flow sensor being adapted to contact a line of a ventilator, to output a flow signal and to relay the flow signal to the flow signal receiver; and  
the line pressure sensor is coupled to the line pressure signal receiver, the line pressure sensor being adapted to contact a line of a ventilator, to output a  
10 line pressure signal and to relay the line pressure signal to the line pressure data receiver.

20. The personal computer card as set forth in Claim 19, wherein:

the flow signal receiver comprises at least one pressure sensor; and  
5 the line pressure signal receiver comprises a pressure sensor.

21. A personal computer card for collecting biological data, comprising:

a flow signal receiver, the flow signal receiver being adapted to receive a flow signal from a flow  
5 sensor and further being adapted to output the flow signal;  
signal-conditioning circuitry operatively coupled to the flow signal receiver, the signal-conditioning circuitry being adapted to receive the flow signal from  
10 the flow signal receiver and to convert the flow signal into digitized flow data; and  
a personal computer card interface operatively coupled to the signal-conditioning circuitry, the

personal computer card interface being adapted to  
15 provide an interface between the personal computer card  
and a host microprocessor system.

22. The personal computer card as set forth in  
Claim 21, wherein the personal computer card interface  
is adapted to relay the digitized flow data to the host  
computer on a real-time basis as the flow signal is  
5 converted by the signal conditioning circuitry.

23. The personal computer card as set forth in  
Claim 21, wherein:

the personal computer card comprises a personal  
computer card housing;

5 the flow signal receiver is coupled to the personal  
computer card housing;

the signal-conditioning circuitry is operatively  
coupled to the flow signal receiver; and

10 the personal computer card interface is disposed  
within the personal computer card housing.

24. The personal computer card as set forth in  
Claim 21, wherein the flow sensor is coupled to the flow  
signal receiver, the flow sensor being adapted to  
contact a line of a ventilator, to output a flow signal  
5 and to relay the flow signal to the flow signal  
receiver.

25. The personal computer card as set forth in  
Claim 24, wherein the flow signal receiver comprises at  
least one pressure sensor.

26. A personal computer card for collecting biological data, comprising:

5 a line pressure signal receiver, the line pressure signal receiver being adapted to receive a line pressure signal from a line pressure sensor and further being adapted to output the line pressure signal;

10 signal-conditioning circuitry operatively coupled to the line pressure signal receiver, the signal-conditioning circuitry being adapted to receive the line pressure signal from the line pressure signal receiver and to convert the line pressure signal into digitized line pressure data; and

15 a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

27. The personal computer card as set forth in Claim 26, wherein the personal computer card interface is adapted to relay the digitized line pressure data to the host computer on a real-time basis as the line  
5 pressure signal is converted by the signal conditioning circuitry.

28. The personal computer card as set forth in Claim 26, wherein:

5 the personal computer card comprises a personal computer card housing;  
the line pressure signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the line pressure signal receiver; and

10 the personal computer card interface is disposed within the personal computer card housing.

29. The personal computer card as set forth in Claim 26, wherein the line pressure sensor is coupled to the line pressure signal receiver, the line pressure sensor being adapted to contact a line of a ventilator, to output a line pressure signal and to relay the line pressure signal to the line pressure receiver.

30. The personal computer card as set forth in Claim 29, wherein the line pressure signal receiver comprises a pressure sensor.

31. A personal computer card for collecting biological data, comprising:

a pulse-oximetry signal receiver, the pulse-oximetry signal receiver being adapted to receive a pulse-oximetry signal from a pulse-oximetry sensor and further being adapted to output the pulse-oximetry signal;

a respiration-rate signal receiver, the respiration-rate signal receiver being adapted to receive a respiration-rate signal from a respiration-rate sensor and further being adapted to output the respiration-rate signal;

a nasal-air pressure/thermistor signal receiver, the nasal-air pressure/thermistor signal receiver being adapted to receive a nasal-air pressure/temperature signal from a nasal-air/thermistor pressure sensor and further being adapted to output the nasal-air pressure/thermistor signal;

signal-conditioning circuitry operatively coupled to at least one of the pulse-oximetry signal receiver, the respiration-rate signal receiver and the nasal-air pressure/thermistor signal receiver, the signal-conditioning circuitry comprising at least one



25 analog-to-digital converter and being adapted to output  
at least one digital signal; and  
a personal computer card interface operatively  
coupled to the signal-conditioning circuitry, the  
personal computer card interface being adapted to  
provide an interface between the personal computer card  
30 and a host microprocessor system.

32. The personal computer card as set forth in  
Claim 31, wherein the personal computer card interface  
is adapted to relay the at least one digital signal to  
the host microprocessor system on a real-time basis as  
5 the at least one digital signal is output by the  
signal-conditioning circuitry.

33. The personal computer card as set forth in  
Claim 31, wherein:

the personal computer card comprises a personal  
computer card housing;

5 the pulse-oximetry signal receiver is coupled to  
the personal computer card housing;

the respiration-rate signal receiver is coupled to  
the personal computer card housing;

10 the nasal-air pressure/thermistor signal receiver  
is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively  
coupled to at least one of the pulse-oximetry signal  
receiver, the respiration-rate signal receiver and the  
nasal-air pressure/thermistor signal receiver; and

15 the personal computer card interface is disposed  
within the personal computer card housing.

34. The personal computer card as set forth in  
Claim 31, wherein:

the pulse-oximetry sensor is coupled to the pulse-oximetry signal receiver, the pulse-oximetry  
5 sensor being adapted to be placed into close proximity with a patient, to output a pulse-oximetry signal and to relay the pulse-oximetry signal to the pulse-oximetry signal receiver;

the respiration-rate sensor is coupled to the  
10 respiration-rate signal receiver, the respiration-rate sensor being adapted to be placed into close proximity with a patient, to output a respiration-rate signal and to relay the respiration-rate signal to the respiration-rate signal receiver;

15 the nasal-air pressure/thermistor sensor is coupled to the nasal-air pressure/thermistor signal receiver, the nasal-air pressure/thermistor sensor being adapted to be placed into close proximity with a patient, to output a nasal-air pressure/thermistor signal and to  
20 relay the nasal-air pressure/thermistor signal to the nasal-air pressure/thermistor signal receiver.

35. The personal computer card as set forth in Claim 34, wherein:

the respiration-rate sensor comprises a chest band and a microphone; and

5 the nasal-air pressure sensor comprises a nasal cannula.

36. The personal computer card as set forth in Claim 35, wherein:

the respiration-rate signal receiver comprises a strain gauge; and

5 the nasal-air pressure/thermistor signal receiver comprises a pressure/thermistor sensor.

37. A personal computer card for collecting biological data, comprising:

a respiration-rate signal receiver, the respiration-rate signal receiver being adapted to receive a respiration-rate signal from a respiration-rate sensor and further being adapted to output the respiration-rate signal;

signal-conditioning circuitry operatively coupled to the respiration-rate signal receiver, the signal-conditioning circuitry being adapted to receive the respiration-rate signal from the respiration-rate signal receiver and to convert the respiration-rate signal into digitized respiration-rate data; and

a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

38. The personal computer card as set forth in Claim 37, wherein the portable computer card interface is adapted to relay the digitized respiration-rate data to the host computer on a real-time basis as the respiration-rate signal is converted by the signal conditioning circuitry.

39. The personal computer card as set forth in Claim 37, wherein:

the personal computer card comprises a personal computer card housing;

the respiration-rate signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the respiration-rate receiver; and

the personal computer card interface is disposed  
10 within the personal computer card housing.

40. The personal computer card as set forth in  
Claim 37, wherein the respiration-rate sensor is coupled  
to the respiration-rate signal receiver, the  
respiration-rate sensor being adapted to be placed into  
5 close proximity with a patient, to output a  
respiration-rate signal and to relay the  
respiration-rate signal to the respiration-rate  
receiver.

41. The personal computer card as set forth in  
Claim 40, wherein the respiration-rate signal receiver  
comprises a strain gauge.

42. A personal computer card for collecting  
biological data, comprising:

a nasal-air pressure/thermistor signal receiver,  
the nasal-air pressure/thermistor signal receiver being  
5 adapted to receive a nasal-air pressure/thermistor  
signal from a nasal-air pressure/thermistor sensor and  
further being adapted to output the nasal-air  
pressure/thermistor signal;

signal-conditioning circuitry operatively coupled  
10 to the nasal-air pressure/thermistor signal receiver,  
the signal-conditioning circuitry being adapted to  
receive the nasal-air pressure/thermistor signal from  
the nasal-air pressure/thermistor signal receiver and to  
convert the nasal-air pressure/thermistor signal into  
15 digitized nasal-air pressure/thermistor data; and

a personal computer card interface operatively  
coupled to the signal-conditioning circuitry, the  
personal computer card interface being adapted to

20 provide an interface between the personal computer card  
and a host microprocessor system.

43. The personal computer card as set forth in  
Claim 42, wherein the portable computer card interface  
is adapted to relay the digitized nasal-air  
pressure/thermistor data to the host computer on a  
5 real-time basis as the nasal-air pressure/thermistor  
signal is converted by the signal conditioning  
circuitry.

44. The personal computer card as set forth in  
Claim 42, wherein:

the personal computer card comprises a personal  
computer card housing;

5 the nasal-air pressure/thermistor signal receiver  
is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively  
coupled to the nasal-air pressure/thermistor signal  
receiver; and

10 the personal computer card interface is disposed  
within the personal computer card housing.

45. The personal computer card as set forth in  
Claim 42, wherein the nasal-air pressure/thermistor  
sensor is coupled to the nasal-air pressure/thermistor  
signal receiver, the nasal-air pressure/thermistor  
5 sensor being adapted to be placed into close proximity  
with a patient, to output a nasal-air  
pressure/thermistor signal and to relay the nasal-air  
pressure/thermistor signal to the nasal-air  
pressure/thermistor signal receiver.

46. The personal computer card as set forth in Claim 45, wherein the nasal-air pressure thermistor signal receiver comprises a pressure/temperature sensor.

47. A personal computer card for collecting biological data, comprising:

an electrocardiography (ECG) signal receiver, the ECG signal receiver being adapted to receive ECG signals from a plurality of ECG sensors and further being adapted to output the ECG signals;

signal-conditioning circuitry operatively coupled to the ECG signal receiver, the signal-conditioning circuitry being adapted to receive the ECG signals from the ECG signal receiver and to output digitized ECG data; and

a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

48. The personal computer card as set forth in Claim 47, wherein the portable computer card interface is adapted to relay the digitized ECG data to the host microprocessor system on a real-time basis as the digitized ECG data is output by the signal-conditioning circuitry.

49. The personal computer card as set forth in Claim 47, wherein:

the personal computer card comprises a personal computer card housing;

the ECG signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the ECG signal receiver; and

the personal computer card interface is disposed  
10 within the personal computer card housing.

50. The personal computer card as set forth in Claim 47, wherein:

the plurality of ECG sensors are coupled to the ECG signal receiver, the plurality of ECG sensors being  
5 adapted to be placed into close proximity with a patient, to output ECG signals and to relay the ECG signals to the ECG signal receiver.

51. A personal computer card for collecting biological data, comprising:

a hydrogen signal receiver, the hydrogen signal receiver being adapted to receive a hydrogen signal from  
5 a hydrogen sensor and further being adapted to output the hydrogen signal;

signal-conditioning circuitry operatively coupled to the hydrogen signal receiver, the signal-conditioning circuitry being adapted to receive the hydrogen signal  
10 from the hydrogen signal receiver and to output digitized hydrogen data; and

a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to  
15 provide an interface between the personal computer card and a host microprocessor system.

52. The personal computer card as set forth in Claim 51, wherein the portable computer card interface is adapted to relay the digitized hydrogen data to the host microprocessor system on a real-time basis as the

5 digitized hydrogen data is output by the  
signal-conditioning circuitry.

53. The personal computer card as set forth in  
Claim 51, wherein:

the personal computer card comprises a personal  
computer card housing;

5 the hydrogen signal receiver is coupled to the  
personal computer card housing;

the signal-conditioning circuitry is operatively  
coupled to the hydrogen signal receiver; and

10 the personal computer card interface is disposed  
within the personal computer card housing.

54. The personal computer card as set forth in  
Claim 51, wherein the hydrogen sensor is coupled to the  
hydrogen signal receiver, the hydrogen sensor being  
adapted to be placed into close proximity with a  
5 patient, to output a hydrogen signal and to relay the  
hydrogen signal to the hydrogen signal receiver.

55. A personal computer card for collecting  
biological data, comprising:

5 an alcohol signal receiver, the alcohol signal  
receiver being adapted to receive an alcohol signal from  
an alcohol sensor and further being adapted to output  
the alcohol signal;

10 signal-conditioning circuitry operatively coupled  
to the alcohol signal receiver, the signal-conditioning  
circuitry being adapted to receive the alcohol signal  
from the alcohol signal receiver and to output digitized  
alcohol data; and

a personal computer card interface operatively  
coupled to the signal-conditioning circuitry, the  
personal computer card interface being adapted to



- 15      provide an interface between the personal computer card  
and a host microprocessor system.

56. The personal computer card as set forth in  
Claim 55, wherein the portable computer card interface  
is adapted to relay the digitized alcohol data to the  
host microprocessor system on a real-time basis as the  
5      digitized alcohol data is output by the  
signal-conditioning circuitry.

57. The personal computer card as set forth in  
Claim 55, wherein:

the personal computer card comprises a personal  
computer card housing;

5      the alcohol signal receiver is coupled to the  
personal computer card housing;

the signal-conditioning circuitry is operatively  
coupled to the alcohol signal receiver; and

10      the personal computer card interface is disposed  
within the personal computer card housing.

58. The personal computer card as set forth in  
Claim 55, wherein the alcohol sensor is coupled to the  
alcohol signal receiver, the alcohol sensor being  
adapted to be placed into close proximity with a  
5      patient, to output an alcohol signal and to relay the  
alcohol signal to the alcohol signal receiver.

59. A personal computer card for collecting  
biological data, comprising:

a pulse-oximetry signal receiver, the  
pulse-oximetry signal receiver being adapted to receive  
5      a pulse-oximetry signal from a pulse-oximetry sensor and  
further being adapted to output the pulse-oximetry  
signal;

10 a respiration-rate signal receiver, the  
respiration-rate signal receiver being adapted to  
receive a respiration-rate signal from a  
respiration-rate sensor and further being adapted to  
output the respiration-rate signal;

15 a nasal-air pressure signal receiver, the nasal-air  
pressure signal receiver being adapted to receive a  
nasal-air pressure signal from a nasal-air pressure  
sensor and further being adapted to output the nasal-air  
pressure signal;

20 a sound signal receiver, the sound signal receiver  
being adapted to receive a sound signal from a sound  
sensor and further being adapted to output the sound  
signal;

25 a motion signal receiver, the motion signal  
receiver being adapted to receive a motion signal from a  
motion sensor and further being adapted to output the  
motion signal;

a position signal receiver, the position signal  
receiver being adapted to receive a position signal from  
a position sensor and further being adapted to output  
the position signal;

30 an electrocardiography (ECG) signal receiver, the  
ECG signal receiver being adapted to receive ECG signals  
from a plurality of ECG sensors and further being  
adapted to output the ECG signals;

35 signal-conditioning circuitry operatively coupled  
to at least one of the pulse-oximetry signal receiver,  
the respiration-rate signal receiver, the nasal-air  
pressure signal receiver, the sound signal receiver, the  
motion signal receiver, the position signal receiver  
and the ECG signal receiver, the signal-conditioning  
40 circuitry comprising at least one analog-to-digital  
converter and being adapted to output at least one  
digital signal; and

45 a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

5 60. The personal computer card as set forth in Claim 59, wherein the portable computer card interface is adapted to relay the at least one digital signal to the host microprocessor system on a real-time basis as the at least one digital signal is output by the signal-conditioning circuitry.

61. The personal computer card as set forth in Claim 59, wherein:

the personal computer card comprises a personal computer card housing;

5 the pulse-oximetry signal receiver is coupled to the personal computer card housing;

the respiration-rate signal receiver is coupled to the personal computer card housing;

10 the nasal-air pressure/thermistor signal receiver is coupled to the personal computer card housing;

the sound signal receiver is coupled to the personal computer card housing;

the motion signal receiver is coupled to the personal computer card housing;

15 the position signal receiver is coupled to the personal computer card housing;

the ECG signal receiver is coupled to the personal computer card housing;

20 the signal-conditioning circuitry is operatively coupled to at least one of the pulse-oximetry signal receiver, the respiration-rate signal receiver, the nasal-air pressure/thermistor signal receiver, the sound

signal receiver, the motion signal receiver, the  
position signal receiver and the ECG signal receiver;  
25 and

the personal computer card interface is disposed  
within the personal computer card housing.

62. The personal computer card as set forth in  
Claim 59, wherein:

the pulse-oximetry sensor is coupled to the  
pulse-oximetry signal receiver, the pulse-oximetry  
5 sensor being adapted to be placed into close proximity  
with a patient, to output a pulse-oximetry signal and to  
relay the pulse-oximetry signal to the pulse-oximetry  
signal receiver;

the respiration-rate sensor is coupled to the  
10 respiration-rate signal receiver, the respiration-rate  
sensor being adapted to be placed into close proximity  
with a patient, to output a respiration-rate signal and  
to relay the respiration-rate signal to the  
respiration-rate signal receiver;

15 the nasal-air pressure/thermistor sensor is coupled  
to the nasal-air pressure/thermistor signal receiver,  
the nasal-air pressure/thermistor sensor being adapted  
to be placed into close proximity with a patient, to  
output a nasal-air pressure/thermistor signal and to  
20 relay the nasal-air pressure/thermistor signal to the  
nasal-air pressure/thermistor signal receiver;

the sound sensor is coupled to the sound signal  
receiver, the sound sensor being adapted to be placed  
into close proximity with a patient, to output a sound  
25 signal and to relay the sound signal to the sound signal  
receiver;

the motion sensor is coupled to the motion signal  
receiver, the motion sensor being adapted to be placed  
into close proximity with a patient, to output a motion

30 signal and to relay the motion signal to the motion  
signal receiver;

the position sensor is coupled to the position  
signal receiver, the position sensor being adapted to be  
placed into close proximity with a patient, to output a  
35 position signal and to relay the position signal to the  
position signal receiver; and

the plurality of ECG sensors are coupled to the ECG  
signal receiver, the plurality of ECG sensors being  
adapted to be placed into close proximity with a  
40 patient, to output ECG signals and to relay the ECG  
signals to the ECG signal receiver.

63. A personal computer card for collecting  
biological data, comprising:

a pulse-oximetry signal receiver, the  
pulse-oximetry signal receiver being adapted to receive  
5 a pulse-oximetry signal from a pulse-oximetry sensor and  
further being adapted to output the pulse-oximetry  
signal;

a respiration-rate signal receiver, the  
respiration-rate signal receiver being adapted to  
10 receive a respiration-rate signal from a  
respiration-rate sensor and further being adapted to  
output the respiration-rate signal;

a nasal-air pressure/thermistor signal receiver,  
the nasal-air pressure/thermistor signal receiver being  
15 adapted to receive a nasal-air pressure/thermistor  
signal from a nasal-air pressure/thermistor sensor and  
further being adapted to output the nasal-air  
pressure/thermistor signal;

a sound signal receiver, the sound signal receiver  
20 being adapted to receive a sound signal from a sound  
sensor and further being adapted to output the sound  
signal;

25 a motion signal receiver, the motion signal receiver being adapted to receive a motion signal from a motion sensor and further being adapted to output the motion signal;

30 a position signal receiver, the position signal receiver being adapted to receive a position signal from a position sensor and further being adapted to output the position signal;

an electrocardiography (ECG) signal receiver, the ECG signal receiver being adapted to receive ECG signals from a plurality of ECG sensors and further being adapted to output the ECG signals;

35 an electroencephalography (EEG) signal receiver, the EEG signal receiver being adapted to receive EEG signals from a plurality of EEG sensors and further being adapted to output the EEG signals;

40 an electrooculogram (EOG) signal receiver, the EOG signal receiver being adapted to receive EOG signals from a plurality of EOG sensors and further being adapted to output the EOG signals;

45 an electromyography (EMG) signal receiver, the EMG signal receiver being adapted to receive EMG signals from a plurality of EMG sensors and further being adapted to output the EMG signals;

50 signal-conditioning circuitry operatively coupled to at least one of the pulse-oximetry signal receiver, the respiration-rate signal receiver, the nasal-air pressure signal receiver, the sound signal receiver, the motion signal receiver, the position signal receiver, the ECG signal receiver, the EEG signal receiver, the EOG signal receiver and the EMG signal receiver, the signal-conditioning circuitry comprising at least one  
55 analog-to-digital converter and being adapted to output at least one digital signal; and

a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

64. The personal computer card as set forth in Claim 63, wherein the portable computer card interface is adapted to relay the at least one digital signal to the host microprocessor system on a real-time basis as the at least one digital signal is output by the signal-conditioning circuitry.

65. The personal computer card as set forth in Claim 63, wherein:

the personal computer card comprises a personal computer card housing;

the pulse-oximetry signal receiver is coupled to the personal computer card housing;

the respiration-rate signal receiver is coupled to the personal computer card housing;

the nasal-air pressure/thermistor signal receiver is coupled to the personal computer card housing;

the sound signal receiver is coupled to the personal computer card housing;

the motion signal receiver is coupled to the personal computer card housing;

the position signal receiver is coupled to the personal computer card housing;

the ECG signal receiver is coupled to the personal computer card housing;

the EEG signal receiver is coupled to the personal computer card housing;

the EOG signal receiver is coupled to the personal computer card housing;

the EMG signal receiver is coupled to the personal computer card housing;

25       the signal-conditioning circuitry is operatively coupled to at least one of the pulse-oximetry signal receiver, the respiration-rate signal receiver, the nasal-air pressure signal receiver, the sound signal receiver, the motion signal receiver, the position  
30       signal receiver, the ECG signal receiver, the EEG signal receiver, the EOG signal receiver and the EMG signal receiver; and

the personal computer card interface is disposed within the personal computer card housing.

66. The personal computer card as set forth in Claim 63, wherein:

the pulse-oximetry sensor is coupled to the pulse-oximetry signal receiver, the pulse-oximetry  
5       sensor being adapted to be placed into close proximity with a patient, to output a pulse-oximetry signal and to relay the pulse-oximetry signal to the pulse-oximetry signal receiver;

the respiration-rate sensor is coupled to the  
10       respiration-rate signal receiver, the respiration-rate sensor being adapted to be placed into close proximity with a patient, to output a respiration-rate signal and to relay the respiration-rate signal to the respiration-rate signal receiver;

15       the nasal-air pressure/thermistor sensor is coupled to the nasal-air pressure/thermistor signal receiver, the nasal-air pressure/thermistor sensor being adapted to be placed into close proximity with a patient, to output a nasal-air pressure/thermistor signal and to  
20       relay the nasal-air pressure/thermistor signal to the nasal-air pressure/thermistor signal receiver;



the sound sensor is coupled to the sound signal receiver, the sound sensor being adapted to be placed into close proximity with a patient, to output a sound signal and to relay the sound signal to the sound signal receiver;

the motion sensor is coupled to the motion signal receiver, the motion sensor being adapted to be placed into close proximity with a patient, to output a motion signal and to relay the motion signal to the motion signal receiver;

the position sensor is coupled to the position signal receiver, the position sensor being adapted to be placed into close proximity with a patient, to output a position signal and to relay the position signal to the position signal receiver;

the plurality of ECG sensors are coupled to the ECG signal receiver, the plurality of ECG sensors being adapted to be placed into close proximity with a patient, to output ECG signals and to relay the ECG signals to the ECG signal receiver;

the plurality of EEG sensors are coupled to the EEG signal receiver, the plurality of EEG sensors being adapted to be placed into close proximity with a patient, to output EEG signals and to relay the EEG signals to the EEG signal receiver;

the plurality of EOG sensors are coupled to the EOG signal receiver, the plurality of EOG sensors being adapted to be placed into close proximity with a patient, to output EOG signals and to relay the EOG signals to the EOG signal receiver; and

the plurality of EMG sensors are coupled to the EMG signal receiver, the plurality of EMG sensors being adapted to be placed into close proximity with a patient, to output EMG signals and to relay the EMG signals to the EMG signal receiver.

67. A personal computer card for collecting biological data, comprising:

a sound signal receiver, the sound signal receiver being adapted to receive a sound signal from a sound sensor and further being adapted to output the sound signal;

signal-conditioning circuitry operatively coupled to the sound signal receiver, the signal-conditioning circuitry being adapted to receive the sound signal from the sound signal receiver and to convert the sound signal into digitized sound signal data; and

a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

68. The personal computer card as set forth in Claim 67, wherein the portable computer card interface is adapted to relay the digitized sound signal data to the host computer on a real-time basis as the sound signal is converted by the signal conditioning circuitry.

69. The personal computer card as set forth in Claim 67, wherein:

the personal computer card comprises a personal computer card housing;

the sound signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the sound signal receiver; and

the personal computer card interface is disposed within the personal computer card housing.

70. The personal computer card as set forth in Claim 67, wherein the sound sensor is coupled to the sound signal receiver, the sound sensor being adapted to be placed into close proximity with a patient, to output  
5 a sound signal and to relay the sound signal to the sound signal receiver.

71. A personal computer card for collecting biological data, comprising:

a motion signal receiver, the motion signal receiver being adapted to receive a motion signal from a motion sensor and further being adapted to output the  
5 motion signal;

signal-conditioning circuitry operatively coupled to the motion signal receiver, the signal-conditioning circuitry being adapted to receive the motion signal  
10 from the motion signal receiver and to convert the motion signal into digitized motion signal data; and

a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to  
15 provide an interface between the personal computer card and a host microprocessor system.

72. The personal computer card as set forth in Claim 71, wherein the portable computer card interface is adapted to relay the digitized motion signal data to the host computer on a real-time basis as the motion  
5 signal is converted by the signal conditioning circuitry.

73. The personal computer card as set forth in Claim 71, wherein:

the personal computer card comprises a personal computer card housing;

5 the motion signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the motion signal receiver; and

10 the personal computer card interface is disposed within the personal computer card housing.

74. The personal computer card as set forth in Claim 67, wherein the motion sensor is coupled to the motion signal receiver, the motion sensor being adapted to be placed into close proximity with a patient, to  
5 output a motion signal and to relay the motion signal to the motion signal receiver.

75. A personal computer card for collecting biological data, comprising:

a position signal receiver, the position signal receiver being adapted to receive a position signal from  
5 a position sensor and further being adapted to output the position signal;

signal-conditioning circuitry operatively coupled to the position signal receiver, the signal-conditioning circuitry being adapted to receive the position signal  
10 from the position signal receiver and to convert the position signal into digitized position signal data; and

a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to  
15 provide an interface between the personal computer card and a host microprocessor system.

76. The personal computer card as set forth in Claim 75, wherein the portable computer card interface

is adapted to relay the digitized position signal data to the host computer on a real-time basis as the  
5 position signal is converted by the signal conditioning circuitry.

77. The personal computer card as set forth in Claim 75, wherein:

the personal computer card comprises a personal computer card housing;

5 the position signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the position signal receiver; and

10 the personal computer card interface is disposed within the personal computer card housing.

78. The personal computer card as set forth in Claim 75, wherein the position sensor is coupled to the position signal receiver, the position sensor being adapted to be placed into close proximity with a  
5 patient, to output a position signal and to relay the position signal to the position signal receiver.

79. A personal computer card for collecting biological data, comprising:

5 an electrooculogram (EOG) signal receiver, the EOG signal receiver being adapted to receive EOG signals from a plurality of EOG sensors and further being adapted to output the EOG signals;

10 signal-conditioning circuitry operatively coupled to the EOG signal receiver, the signal-conditioning circuitry being adapted to receive the EOG signals from the EOG signal receiver and to output digitized EOG data; and

a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

80. The personal computer card as set forth in Claim 79, wherein the portable computer card interface is adapted to relay the digitized EOG data to the host microprocessor system on a real-time basis as the digitized EOG data is output by the signal-conditioning circuitry.

81. The personal computer card as set forth in Claim 79, wherein:

the personal computer card comprises a personal computer card housing;

the EOG signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the EOG signal receiver; and

the personal computer card interface is disposed within the personal computer card housing.

82. The personal computer card as set forth in Claim 79, wherein:

the plurality of EOG sensors are coupled to the EOG signal receiver, the plurality of EOG sensors being adapted to be placed into close proximity with a patient, to output EOG signals and to relay the EOG signals to the EOG signal receiver.

83. A personal computer card for collecting biological data, comprising:

an electromyography (EMG) signal receiver, the EMG  
signal receiver being adapted to receive EMG signals  
5 from a plurality of EMG sensors and further being  
adapted to output the EMG signals;

signal-conditioning circuitry operatively coupled  
to the EMG signal receiver, the signal-conditioning  
circuitry being adapted to receive the EMG signals from  
10 the EMG signal receiver and to output digitized EMG  
data; and

a personal computer card interface operatively  
coupled to the signal-conditioning circuitry, the  
personal computer card interface being adapted to  
15 provide an interface between the personal computer card  
and a host microprocessor system.

84. The personal computer card as set forth in  
Claim 83, wherein the portable computer card interface  
is adapted to relay the digitized EMG data to the host  
microprocessor system on a real-time basis as the  
5 digitized EMG data is output by the signal-conditioning  
circuitry.

85. The personal computer card as set forth in  
Claim 83, wherein:

the personal computer card comprises a personal  
computer card housing;

5 the EMG signal receiver is coupled to the personal  
computer card housing;

the signal-conditioning circuitry is operatively  
coupled to the EMG signal receiver; and

10 the personal computer card interface is disposed  
within the personal computer card housing.

86. The personal computer card as set forth in  
Claim 83, wherein:

the plurality of EMG sensors are coupled to the EMG signal receiver, the plurality of EMG sensors being adapted to be placed into close proximity with a patient, to output EMG signals and to relay the EMG signals to the EMG signal receiver.

87. A personal computer card for collecting biological data, comprising:

a fetal heart-rate signal receiver, the fetal heart-rate signal receiver being adapted to receive a fetal heart-rate signal from a fetal heart-rate sensor and further being adapted to output the fetal heart-rate signal;

a contraction signal receiver, the contraction signal receiver being adapted to receive a contraction signal from a contraction sensor and further being adapted to output the contraction signal;

signal-conditioning circuitry operatively coupled to at least one of the fetal heart-rate signal receiver and the contraction signal receiver, the signal-conditioning circuitry comprising at least one analog-to-digital converter and being adapted to output at least one digital signal; and

a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

88. The personal computer card as set forth in Claim 87, wherein the portable computer card interface is adapted to relay the at least one digital signal to the host microprocessor system on a real-time basis as the at least one digital signal is output by the signal-conditioning circuitry.



89. The personal computer card as set forth in Claim 87, wherein:

the personal computer card comprises a personal computer card housing;

5 the fetal heart-rate signal receiver is coupled to the personal computer card housing;

the contraction signal receiver is coupled to the personal computer card housing;

10 the signal-conditioning circuitry is operatively coupled to at least one of the fetal heart-rate receiver and the contraction signal receiver; and

the personal computer card interface is disposed within the personal computer card housing.

90. The personal computer card as set forth in Claim 87, wherein:

5 the fetal heart-rate sensor is coupled to the fetal heart-rate signal receiver, the fetal heart-rate sensor being adapted to be placed into close proximity with a patient, to output a fetal heart-rate signal and to relay the fetal heart-rate signal to the fetal heart-rate signal receiver; and

10 the contraction sensor is coupled to the contraction signal receiver, the contraction sensor being adapted to be placed into close proximity with a patient, to output a contraction signal and to relay the contraction signal to the contraction signal receiver.

91. A personal computer card for collecting biological data, comprising: a fetal heart-rate signal receiver, the fetal heart-rate signal receiver being adapted to receive a fetal heart-rate signal from a fetal heart-rate sensor and further being adapted to output the fetal heart-rate signal;

signal-conditioning circuitry operatively coupled to the fetal heart-rate signal receiver, the signal-conditioning circuitry being adapted to receive  
10 the fetal heart-rate signal from the fetal heart-rate signal receiver and to convert the fetal heart-rate signal into digitized fetal heart-rate data; and  
a personal computer card interface operatively coupled to the signal-conditioning circuitry, the  
15 personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

92. The personal computer card as set forth in Claim 91 wherein the portable computer card interface is adapted to relay the digitized fetal heart-rate data to the host computer on a real-time basis as the fetal  
5 heart-rate signal is converted by the signal conditioning circuitry.

93. The personal computer card as set forth in Claim 91, wherein:

the personal computer card comprises a personal computer card housing;  
5 the fetal heart-rate signal receiver is coupled to the personal computer card housing;  
the signal-conditioning circuitry is operatively coupled to the fetal heart-rate signal receiver; and  
the personal computer card interface is disposed  
10 within the personal computer card housing.

94. The personal computer card as set forth in Claim 91, wherein the fetal heart-rate sensor is coupled to the fetal heart-rate signal receiver, the fetal heart-rate sensor being adapted to be placed into close  
5 proximity with a patient, to output a fetal heart-rate

signal and to relay the fetal heart-rate signal to the fetal heart-rate receiver.

95. A personal computer card for collecting biological data, comprising:

5 a contraction signal receiver, the contraction signal receiver being adapted to receive a contraction signal from a contraction sensor and further being adapted to output the contraction signal;

10 signal-conditioning circuitry operatively coupled to the contraction signal receiver, the signal-conditioning circuitry being adapted to receive the contraction signal from the contraction signal receiver and to convert the contraction signal into digitized contraction data; and

15 a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

96. The personal computer card as set forth in Claim 95, wherein the portable computer card interface is adapted to relay the digitized contraction data to the host computer on a real-time basis as the  
5 contraction signal is converted by the signal conditioning circuitry.

97. The personal computer card as set forth in Claim 95, wherein:

the personal computer card comprises a personal computer card housing;

5 the contraction signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the contraction signal receiver; and  
the personal computer card interface is disposed  
10 within the personal computer card housing.

98. The personal computer card as set forth in Claim 95, wherein the contraction sensor is coupled to the contraction signal receiver, the contraction sensor being adapted to be placed into close proximity with a  
5 patient, to output a contraction signal and to relay the contraction signal to the contraction receiver.

99. A personal computer card for collecting biological data, comprising:  
a blood glucose signal receiver, the blood glucose signal receiver being adapted to receive a blood glucose  
5 signal from a blood glucose sensor and further being adapted to output the blood glucose signal;  
signal-conditioning circuitry operatively coupled to the blood glucose signal receiver, the signal-conditioning circuitry being adapted to receive  
10 the blood glucose signal from the blood glucose signal receiver and to output digitized blood glucose data; and  
a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to  
15 provide an interface between the personal computer card and a host microprocessor system.

100. The personal computer card as set forth in Claim 99, wherein the portable computer card interface is adapted to relay the digitized blood glucose data to the host computer on a real-time basis as the digitized  
5 blood glucose data is output by the signal-conditioning circuitry.

101. The personal computer card as set forth in Claim 99, wherein:

the personal computer card comprises a personal computer card housing;

5 the blood glucose signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the blood glucose signal receiver; and

10 the personal computer card interface is disposed within the personal computer card housing.

102. The personal computer card as set forth in Claim 99, wherein:

the blood glucose sensor comprises a non-invasive blood glucose sensor; and

5 the blood glucose sensor is coupled to the blood glucose signal receiver, the blood glucose sensor being adapted to be placed into close proximity with a patient, to output a blood glucose signal and to relay the blood glucose signal to the blood glucose signal receiver.

103. A personal computer card for collecting biological data, comprising:

5 a blood cholesterol signal receiver, the blood cholesterol signal receiver being adapted to receive a blood cholesterol signal from a blood cholesterol sensor and further being adapted to output the blood cholesterol signal;

10 signal-conditioning circuitry operatively coupled to the blood cholesterol signal receiver, the signal-conditioning circuitry being adapted to receive the blood cholesterol signal from the blood cholesterol

signal receiver and to output digitized blood cholesterol data; and

15 a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

104. The personal computer card as set forth in Claim 103, wherein the portable computer card interface is adapted to relay the digitized blood cholesterol data to the host computer on a real-time basis as the  
5 digitized blood cholesterol data is output by the signal-conditioning circuitry.

105. The personal computer card as set forth in Claim 103, wherein:

the personal computer card comprises a personal computer card housing;

5 the blood cholesterol signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the blood cholesterol signal receiver; and

10 the personal computer card interface is disposed within the personal computer card housing.

106. The personal computer card as set forth in Claim 103, wherein:

the blood cholesterol sensor comprises a non-invasive blood cholesterol sensor; and

5 the blood cholesterol sensor is coupled to the blood cholesterol signal receiver, the blood cholesterol sensor being adapted to be placed into close proximity with a patient, to output a blood cholesterol signal and

to relay the blood cholesterol signal to the blood  
10 cholesterol signal receiver.

107. A personal computer card for collecting  
biological data, comprising:

a oxygen signal receiver, the oxygen signal  
receiver being adapted to receive a oxygen signal from a  
5 oxygen sensor and further being adapted to output the  
oxygen signal;

a carbon-dioxidel signal receiver, the  
carbon-dioxide signal receiver being adapted to receive  
a carbon-dioxide signal from a carbon-dioxide sensor and  
10 further being adapted to output the carbon-dioxide  
signal;

a nitrogen signal receiver, the nitrogen signal  
receiver being adapted to receive a nitrogen signal from  
a nitrogen sensor and further being adapted to output  
15 the nitrogen signal;

signal-conditioning circuitry operatively coupled  
to at least one of the oxygen signal receiver, the  
carbon-dioxidel signal receiver and the nitrogen signal  
receiver, the signal-conditioning circuitry comprising  
20 at least one analog-to-digital converter and being  
adapted to output at least one digital signal; and

a personal computer card interface operatively  
coupled to the signal-conditioning circuitry, the  
personal computer card interface being adapted to  
25 provide an interface between the personal computer card  
and a host microprocessor system.

108. The personal computer card as set forth in  
Claim 107, wherein the portable computer card interface  
is adapted to relay the at least one digital signal to  
the host microprocessor system on a real-time basis as

5 the at least one digital signal is output by the signal-conditioning circuitry.

109. The personal computer card as set forth in Claim 107, wherein:

the personal computer card comprises a personal computer card housing;

5 the oxygen signal receiver is coupled to the personal computer card housing;

the carbon-dioxide signal receiver is coupled to the personal computer card housing;

10 the nitrogen signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to at least one of the oxygen signal receiver, the carbon-dioxide signal receiver and the nitrogen signal receiver; and

15 the personal computer card interface is disposed within the personal computer card housing.

110. The personal computer card as set forth in Claim 107, wherein:

the oxygen sensor comprises a non-invasive oxygen sensor;

5 the oxygen sensor is coupled to the oxygen signal receiver, the oxygen sensor being adapted to be placed into close proximity with a patient, to output a oxygen signal and to relay the oxygen signal to the oxygen signal receiver;

10 the carbon-dioxide sensor comprises a non-invasive carbon-dioxide sensor;

the carbon-dioxide sensor is coupled to the carbon-dioxide signal receiver, the carbon-dioxide sensor being adapted to be placed into close proximity  
15 with a patient, to output a carbon-dioxide signal and to



relay the carbon-dioxide signal to the carbon-dioxide signal receiver;

the nitrogen sensor comprises a non-invasive nitrogen sensor; and

20 the nitrogen sensor is coupled to the nitrogen signal receiver, the nitrogen sensor being adapted to be placed into close proximity with a patient, to output a nitrogen signal and to relay the nitrogen signal to the nitrogen signal receiver.

111. The personal computer card as set forth in Claim 107, wherein:

5 the personal computer card further comprises a carbon-monoxide signal receiver, the carbon-monoxide signal receiver being adapted to receive a carbon-monoxide signal from a carbon-monoxide sensor and further being adapted to output the carbon-monoxide signal;

10 the signal-conditioning circuitry is operatively coupled to at least one of the oxygen signal receiver, the carbon-dioxide signal receiver, the nitrogen signal receiver and the carbon-dioxide signal receiver.

112. A personal computer card for collecting biological data, comprising:

5 a carbon dioxide receiver, the carbon dioxide signal receiver being adapted to receive a carbon dioxide signal from a carbon dioxide sensor and further being adapted to output the carbon dioxide signal;

10 signal-conditioning circuitry operatively coupled to the carbon dioxide signal receiver, the signal-conditioning circuitry being adapted to receive the carbon dioxide signal from the carbon dioxide signal receiver and to output digitized carbon dioxide data; and

15 a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

113. The personal computer card as set forth in Claim 112, wherein the portable computer card interface is adapted to relay the digitized carbon dioxide data to the host computer on a real-time basis as the  
5 digitized carbon dioxide data is output by the signal-conditioning circuitry.

114. The personal computer card as set forth in Claim 112, wherein:

the personal computer card comprises a personal computer card housing;

5 the carbon dioxide signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the carbon dioxide signal receiver; and

10 the personal computer card interface is disposed within the personal computer card housing.

115. The personal computer card as set forth in Claim 112, wherein:

the carbon dioxide sensor comprises a non-invasive carbon dioxide sensor; and

5 the carbon dioxide sensor is coupled to the carbon dioxide signal receiver, the oxygen sensor being adapted to be placed into close proximity with a patient, to output a carbon dioxide signal and to relay the carbon dioxide signal to the carbon dioxide signal  
10 receiver.

116. A personal computer card for collecting biological data, comprising:

5 a nitrogen receiver, the nitrogen signal receiver being adapted to receive a nitrogen signal from a nitrogen sensor and further being adapted to output the nitrogen signal;

10 signal-conditioning circuitry operatively coupled to the nitrogen signal receiver, the signal-conditioning circuitry being adapted to receive the nitrogen signal from the nitrogen signal receiver and to output digitized nitrogen data; and

15 a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

117. The personal computer card as set forth in Claim 116, wherein the portable computer card interface is adapted to relay the digitized nitrogen data to the host computer on a real-time basis as the digitized nitrogen data is output by the signal-conditioning circuitry.

118. The personal computer card as set forth in Claim 116, wherein:

5 the personal computer card comprises a personal computer card housing;

the nitrogen signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the nitrogen signal receiver; and

10 the personal computer card interface is disposed within the personal computer card housing.

119. The personal computer card as set forth in Claim 116, wherein:

the nitrogen sensor comprises a non-invasive nitrogen sensor; and

5 the nitrogen sensor is coupled to the nitrogen signal receiver, the nitrogen sensor being adapted to be placed into close proximity with a patient, to output a nitrogen signal and to relay the nitrogen signal to the nitrogen signal receiver.

120. A personal computer card for collecting biological data, comprising:

a carbon monoxide receiver, the carbon monoxide signal receiver being adapted to receive a carbon monoxide signal from a carbon monoxide sensor and further being adapted to output the carbon monoxide signal;

10 signal-conditioning circuitry operatively coupled to the carbon monoxide signal receiver, the signal-conditioning circuitry being adapted to receive the carbon monoxide signal from the carbon monoxide signal receiver and to output digitized carbon monoxide data; and

15 a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

121. The personal computer card as set forth in Claim 120, wherein the portable computer card interface is adapted to relay the digitized carbon monoxide data to the host computer on a real-time basis as the digitized carbon monoxide data is output by the signal-conditioning circuitry.

122. The personal computer card as set forth in Claim 120, wherein:

the personal computer card comprises a personal computer card housing;

5 the carbon monoxide signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the carbon monoxide signal receiver; and

10 the personal computer card interface is disposed within the personal computer card housing.

123. The personal computer card as set forth in Claim 120, wherein:

the carbon monoxide sensor comprises a non-invasive carbon monoxide sensor; and

5 the carbon monoxide sensor is coupled to the carbon monoxide signal receiver, the carbon monoxide sensor being adapted to be placed into close proximity with a patient, to output a carbon monoxide signal and to relay the carbon monoxide signal to the carbon  
10 monoxide signal receiver.

124. A personal computer card for collecting biological data, comprising:

an oxygen signal receiver, the oxygen signal receiver being adapted to receive an oxygen signal from  
5 an oxygen sensor and further being adapted to output the oxygen signal;

signal-conditioning circuitry operatively coupled to the oxygen signal receiver, the signal-conditioning circuitry being adapted to receive the oxygen signal  
10 from the oxygen signal receiver and to output digitized oxygen data; and

a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

125. The personal computer card as set forth in Claim 124, wherein the portable computer card interface is adapted to relay the digitized oxygen data to the host microprocessor system on a real-time basis as the digitized oxygen data is output by the signal-conditioning circuitry.

126. The personal computer card as set forth in Claim 124, wherein:

the personal computer card comprises a personal computer card housing;

the oxygen signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the oxygen signal receiver; and

the personal computer card interface is disposed within the personal computer card housing.

127. The personal computer card as set forth in Claim 124, wherein the oxygen sensor is coupled to the oxygen signal receiver, the oxygen sensor being adapted to be placed into close proximity with a patient, to output an oxygen signal and to relay the oxygen signal to the oxygen signal receiver.

128. A personal computer card for collecting biological data, comprising:

a first conductor signal receiver, the first conductor signal receiver being adapted to receive a

5 first conductor signal from a first conductor, the first conductor being adapted to be placed into close proximity with a patient;

a second conductor signal receiver, the second conductor signal receiver being adapted to receive a  
10 second conductor signal from a second conductor, the second conductor being adapted to be placed into close proximity with a patient;

signal-conditioning circuitry operatively coupled to the first conductor signal receiver and the second  
15 conductor receiver, the signal-conditioning circuitry being adapted to receive the first conductor signal from the first conductor signal receiver and being adapted to receive the second conductor signal from the second conductor signal receiver; and

20 a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

129. The personal computer card for collecting biological data as set forth in Claim 128, and further comprising:

a current source adapted to apply a predetermined  
5 current to at least one of the first conductor signal receiver and the second conductor signal receiver; and

an electrical resistance detector, the electrical resistance detector being adapted to determine an electrical resistance of the patient, based on the  
10 predetermined current applied by the current source.

130. The personal computer card for collecting biological data as set forth in Claim 128, wherein:

at least one of the first conductor signal receiver and the second conductor signal receiver is adapted to receive a predetermined current from a current source on the host microprocessor system; and

an electrical resistance between the first conductor signal receiver and the second conductor signal receiver can be determined by an electrical resistance detector on the host microprocessor system, the electrical resistance detector being adapted to determine an electrical resistance of the patient, based on the predetermined current applied by the current source.

131. The personal computer card as set forth in Claim 129, wherein the electrical resistance detector is adapted to determine a body composition of the patient.

132. The personal computer card as set forth in Claim 131, wherein the body composition of the patient comprises a fat composition of the patient.

133. The personal computer card as set forth in Claim 131, wherein the portable computer card interface is adapted to relay the electrical resistance to the host microprocessor system on a real-time basis as the electrical resistance detector determines the electrical resistance of the patient.

134. The personal computer card as set forth in Claim 129, wherein:

the personal computer card comprises a personal computer card housing;

the current source is coupled to the personal computer card housing;



the electrical resistance detector is operatively coupled to the personal computer card housing; and  
the personal computer card interface is disposed  
10 within the personal computer card housing.

135. The personal computer card as set forth in Claim 129, wherein:

the first conductor is coupled to the first  
conductor signal receiver, the first conductor being  
5 adapted to be placed into close proximity with a  
patient; are coupled to the ECG signal receiver, the  
plurality of ECG sensors being adapted to be placed into  
close proximity with a patient, to output ECG signals  
and to relay the ECG signals to the ECG signal receiver.

136. A personal computer card for collecting biological data, comprising:

a heart-beat signal receiver, the heart beat signal  
receiver being adapted to receive a heart beat signal  
5 from a heart beat sensor and further being adapted to  
output the heart beat signal;

signal-conditioning circuitry operatively coupled  
to the heart beat signal receiver, the  
signal-conditioning circuitry comprising at least one  
10 analog-to-digital converter and being adapted to output  
at least one digital signal; and

a personal computer card interface operatively  
coupled to the signal-conditioning circuitry, the  
personal computer card interface being adapted to  
15 provide an interface between the personal computer card  
and a host microprocessor system.

137. The personal computer card as set forth in Claim 136, wherein the portable computer card interface is adapted to relay the at least one digital signal to

the host microprocessor system on a real-time basis as  
5 the at least one digital signal is output by the  
signal-conditioning circuitry.

138. The personal computer card as set forth in  
Claim 136, wherein;

the personal computer card comprises a personal  
computer card housing;

5 the heart-beat signal receiver is coupled to the  
personal computer card housing;

the signal-conditioning circuitry is operatively  
coupled to the heart-beat signal receiver; and

10 the personal computer card interface is disposed  
within the personal computer card housing.

139. The personal computer card as set forth in  
Claim 136, wherein the heart-beat sensor is coupled to  
the heart-beat signal receiver, the heart-beat sensor  
being adapted to be placed into close proximity with a  
5 patient, to output a heart-beat signal and to relay the  
heart-beat signal to the heart-beat signal.

140. A personal computer card for collecting  
biological data, comprising:

an ear probe signal receiver, the ear probe signal  
receiver being adapted to receive an ear probe signal  
5 from an ear probe sensor and further being adapted to  
output the ear probe signal;

signal-conditioning circuitry operatively coupled  
to the ear probe signal receiver, the  
signal-conditioning circuitry comprising at least one  
10 analog-to-digital converter and being adapted to output  
at least one digital signal; and

a personal computer card interface operatively  
coupled to the signal-conditioning circuitry, the

15       personal computer card interface being adapted to  
provide an interface between the personal computer card  
and a host microprocessor system.

141. The personal computer card as set forth in  
Claim 140, wherein the portable computer card interface  
is adapted to relay the at least one digital signal to  
the host microprocessor system on a real-time basis as  
5       the at least one digital signal is output by the  
signal-conditioning circuitry.

142. The personal computer card as set forth in  
Claim 140, wherein:

the personal computer card comprises a personal  
computer card housing;

5       the ear probe signal receiver is coupled to the  
personal computer card housing;

the signal-conditioning circuitry is operatively  
coupled to the ear probe signal receiver; and

10       the personal computer card interface is disposed  
within the personal computer card housing.

143. The personal computer card as set forth in  
Claim 140, wherein the ear probe sensor is coupled to  
the ear probe signal receiver, the ear probe sensor  
being adapted to be placed into close proximity with a  
5       patient, to output an ear probe signal and to relay the  
ear probe signal to the ear probe signal receiver.

144. The personal computer card as set forth in  
Claim 143, wherein:

the ear probe sensor comprises a hand-held wand  
adapted to be placed into an ear of a patient; and

5           the ear probe sensor is adapted to measure a pressure of an eardrum of the patient.

145. A personal computer card for collecting biological data, comprising:

5           a pencil probe signal receiver, the pencil probe signal receiver being adapted to receive a pencil probe signal from a pencil probe sensor and further being adapted to output the pencil probe signal;

10           signal-conditioning circuitry operatively coupled to the pencil probe signal receiver, the signal-conditioning circuitry comprising at least one analog-to-digital converter and being adapted to output at least one digital signal; and

15           a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

146. The personal computer card as set forth in Claim 145, wherein the portable computer card interface is adapted to relay the at least one digital signal to the host microprocessor system on a real-time basis as the at least one digital signal is output by the signal-conditioning circuitry.

147. The personal computer card as set forth in Claim 145, wherein:

          the personal computer card comprises a personal computer card housing;

5           the pencil probe signal receiver is coupled to the personal computer card housing;

          the signal-conditioning circuitry is operatively coupled to the pencil probe signal receiver; and

the personal computer card interface is disposed  
10 within the personal computer card housing.

148. The personal computer card as set forth in  
Claim 145, wherein the pencil probe sensor is coupled to  
the pencil probe signal receiver, the pencil probe  
sensor being adapted to be placed into close proximity  
5 with a patient, to output a pencil probe signal and to  
relay the pencil probe signal to the pencil probe signal  
receiver.

149. The personal computer card as set forth in  
Claim 148, wherein:

the pencil probe sensor comprises a hand-held wand  
adapted to emit acoustical signals; and

5 the pencil probe sensor is adapted to measure a  
flow of the patient, based upon the emitted acoustical  
signals.

150. A personal computer card for collecting  
biological data, comprising:

a pencil probe signal receiver, the pencil probe  
signal receiver being adapted to receive a pencil probe  
5 signal from a pencil probe sensor and further being  
adapted to output the pencil probe signal;

signal-conditioning circuitry operatively coupled  
to the pencil probe signal receiver, the  
signal-conditioning circuitry comprising at least one  
10 analog-to-digital converter and being adapted to output  
at least one digital signal; and

a personal computer card interface operatively  
coupled to the signal-conditioning circuitry, the  
personal computer card interface being adapted to  
15 provide an interface between the personal computer card  
and a host microprocessor system.

151. The personal computer card as set forth in Claim 150, wherein the portable computer card interface is adapted to relay the at least one digital signal to the host microprocessor system on a real-time basis as  
5 the at least one digital signal is output by the signal-conditioning circuitry.

152. The personal computer card as set forth in Claim 150, wherein:

the personal computer card comprises a personal computer card housing;

5 the pencil probe signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the pencil probe signal receiver; and

10 the personal computer card interface is disposed within the personal computer card housing.

153. The personal computer card as set forth in Claim 150, wherein the pencil probe sensor is coupled to the pencil probe signal receiver, the pencil probe sensor being adapted to be placed into close proximity  
5 with a patient, to output a pencil probe signal and to relay the pencil probe signal to the pencil probe signal receiver.

154. The personal computer card as set forth in Claim 153, wherein:

the pencil probe sensor comprises a hand-held wand adapted to emit acoustical signals; and

5 the pencil probe sensor is adapted to measure a blood flow of the patient, based upon the emitted acoustical signals.

155. A personal computer card for collecting biological data, comprising:

an electroencepholography (EEG) signal receiver, the EEG signal receiver being adapted to receive EEG signals from a plurality of EEG sensors and further being adapted to output the EEG signals;

signal-conditioning circuitry operatively coupled to the EEG signal receiver, the signal-conditioning circuitry comprising at least one analog-to-digital converter and being adapted to output at least one digital signal; and

a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to provide an interface between the personal computer card and a host microprocessor system.

156. The personal computer card as set forth in Claim 155, wherein the portable computer card interface is adapted to relay the at least one digital signal to the host microprocessor system on a real-time basis as the at least one digital signal is output by the signal-conditioning circuitry.

157. The personal computer card as set forth in Claim 155, wherein:

the personal computer card comprises a personal computer card housing;

the EEG signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled the EEG signal receiver; and

the personal computer card interface is disposed within the personal computer card housing.

158. The personal computer card as set forth in Claim 155, wherein the plurality of EEG sensors are coupled to the EEG signal receiver, the plurality of EEG sensors being adapted to be placed into close proximity with a patient, to output EEG signals and to relay the EEG signals to the EEG signal receiver.

159. A portable biological data collection device, comprising:

a personal computer card housing;

a biological data receiver coupled to the personal computer card housing, the biological data receiver being adapted to receive biological data and to output the biological data;

signal-conditioning circuitry operatively coupled to the biological data receiver, the signal-conditioning circuitry being adapted to receive the biological data from the biological data receiver and to convert the biological data into digitized biological data; and

a personal computer card interface disposed within the personal computer card housing, the personal computer card interface being adapted to communicate with a set-top box and to relay the digitized biological data to the set-top box on a real-time basis as the biological data is converted by the signal conditioning circuitry.

160. The portable biological data collection device as set forth in Claim 159, wherein:

the set-top box comprises a host microprocessor system; and

the personal computer card interface is adapted to relay the digitized biological data to the set-top box on a real-time basis for transmission by the set-top box to another host microprocessor system.



161. A portable biological data collection device, comprising:

a game-set card housing;

5 a biological data receiver coupled to the game-set card housing, the biological data receiver being adapted to receive biological data and to output the biological data;

10 signal-conditioning circuitry operatively coupled to the biological data receiver, the signal-conditioning circuitry being adapted to receive the biological data from the biological data receiver and to convert the biological data into digitized biological data; and

15 a game-set card interface disposed within the game-set card housing, the game-set card interface being adapted to communicate with a game-set and to relay the digitized biological data to the game-set on a real-time basis as the biological data is converted by the signal conditioning circuitry.

162. The portable biological data collection device as set forth in Claim 161, wherein:

the game-set card housing comprises a personal computer card housing; and

5 the game-set card interface comprises a personal computer card interface.

163. The host microprocessor system as set forth in Claim 161, wherein the game-set card housing comprises a compact flash card.

164. A portable biological data collection device, comprising:

a computer card housing;

5 a biological data receiver coupled to the computer card housing, the biological data receiver being adapted to receive biological data and to output the biological data;

10 signal-conditioning circuitry operatively coupled to the biological data receiver, the signal-conditioning circuitry being adapted to receive the biological data from the biological data receiver and to convert the biological data into digitized biological data; and

15 a compact flash card interface disposed within the computer card housing, the compact flash card interface being adapted to communicate with a host microprocessor system and to relay the digitized biological data to the host microprocessor system on a real-time basis as the biological data is converted by the signal conditioning circuitry.

165. A host microprocessor system configurable among a plurality of biological data collection device modes, comprising:

5 a personal computer card slot adapted to receive a personal computer card therein;

10 a personal computer card interface adapted to communicate with a personal computer card inserted into the personal computer card slot and adapted to receive digitized biological data from a personal computer card inserted into the personal computer card slot;

a microprocessor;

a data bus operatively connected between the microprocessor and the personal computer card interface;

15 an input device adapted to receive designation data from a personal computer card within the personal computer card slot, the input device being operatively connected to the microprocessor and the designation data being indicative of a type of the digitized biological

20 data from a personal computer card inserted into the  
personal computer card slot, the designation data  
comprising one of a first identifier and a second  
25 identifier, the first identifier indicating that the  
digitized biological data should be interpreted by the  
microprocessor as first biological data and the second  
25 identifier indicating that the digitized biological data  
should be interpreted by the microprocessor as second  
biological data; and

a configurer adapted to configure the host  
microprocessor system into a first real-time biological  
30 data collecting and analyzing device upon receipt of the  
first identifier, and adapted to configure the host  
microprocessor system into a second real-time biological  
data collecting and analyzing device upon receipt of the  
second identifier, the configurer being operatively  
35 connected to the microprocessor.

166. The host microprocessor system as set forth in  
Claim 165, the designation data comprising a third  
5 identifier indicating that the digitized biological data  
should be interpreted by the microprocessor as third  
biological data, and the host microprocessor system  
being configurable into a third real-time biological  
data collecting and analyzing device.

167. The host microprocessor system as set forth in  
Claim 165, wherein:

the host microprocessor system comprises a set-top  
box; and

5 the set-top box is adapted to receive the digitized  
biological data and to transmit the digitized biological  
data to at least one other host microprocessor system.

168. The host microprocessor system as set forth in Claim 167, wherein the set-top box is adapted to transmit the digitized biological data real-time to the at least one other host microprocessor system.

169. The host microprocessor system as set forth in Claim 167, wherein the set-top box is adapted to transmit the digitized biological data to the at least one other host microprocessor system at a later time  
5 either automatically at predetermined intervals or upon transmit instructions.

170. The host microprocessor system as set forth in Claim 165, wherein the host microprocessor system comprises a game set.

171. The host microprocessor system as set forth in Claim 165, wherein:

the personal computer card slot is adapted to receive a compact flash card therein;

5 the personal computer card interface is adapted to communicate with a compact flash card inserted into the personal computer card slot.

## AMENDED CLAIMS

[received by the International Bureau on 24 March 2000 (24.03.00);  
original claims 16 and 74 amended; remaining claims unchanged (3 pages)]

13. The personal computer card as set forth in  
Claim 12, wherein the personal computer card interface  
is adapted to relay the digitized blood-pressure data to  
5 the host computer on a real-time basis as the blood-  
pressure signal is converted by the signal conditioning  
circuitry.

14. The personal computer card as set forth in  
Claim 12, wherein:

the personal computer card comprises a personal  
card housing;

5 the blood-pressure signal receiver is coupled to  
the personal computer card housing;

the signal-conditioning circuitry is operatively  
coupled to the blood-pressure signal receiver; and

10 the personal computer card interface is disposed  
within the personal computer card housing.

15. The personal computer card as set forth in  
Claim 12, wherein the blood-pressure data sensor is  
coupled to the blood-pressure signal receiver, the  
blood-pressure data sensor being adapted to be placed  
5 into close proximity with a patient, to output a blood-  
pressure signal and to relay the blood-pressure signal  
to the blood-pressure receiver.

16. A personal computer card for collecting  
biological data, comprising:

a flow signal receiver, the flow signal receiver  
being adapted to receive a flow signal from a flow  
5 sensor and further being adapted to output the flow  
signal;

a line pressure signal receiver, the line pressure  
signal receiver being adapted to receive a line pressure

10 signal from a line pressure sensor and further being  
adapted to output the line pressure signal;  
signal-conditioning circuitry operatively coupled  
to at least one of the flow signal receiver and the line  
pressure signal receiver, the signal-conditioning  
15 circuitry comprising at least one analog-to-digital  
converter and being adapted to output at least one  
digital signal; and  
a personal computer card interface operatively  
coupled to the signal-conditioning circuitry, the  
20 personal computer card interface being adapted to  
provide an interface between the personal computer card  
and a host microprocessor system.

17. The personal computer card as set forth in  
Claim 16, wherein the personal computer card interface  
is adapted to relay the at least one digital signal to  
the host microprocessor system on a real-time basis as  
5 the at least one digital signal is output by the signal-  
conditioning circuitry.

18. The personal computer card as set forth in  
Claim 16, wherein:  
the personal computer card comprises a personal  
computer card housing;  
5 the flow signal receiver is coupled to the personal  
computer card housing;  
the line pressure signal receiver is coupled to the  
personal computer card housing;  
the signal-conditioning circuitry is operatively  
10 coupled to at least one of the flow signal receiver and  
the line pressure signal receiver; and

the personal computer card comprises a personal computer card housing;

5 the motion signal receiver is coupled to the personal computer card housing;

the signal-conditioning circuitry is operatively coupled to the motion signal receiver; and

10 the personal computer card interface is disposed within the personal computer card housing.

74. The personal computer card as set forth in Claim 71, wherein the motion sensor is coupled to the motion signal receiver, the motion sensor being adapted to be placed into close proximity with a patient, to  
5 output a motion signal and to relay the motion signal to the motion signal receiver.

75. A personal computer card for collecting biological data, comprising:

a position signal receiver, the position signal receiver being adapted to receive a position signal from  
5 a position sensor and further being adapted to output the position signal;

10 signal-conditioning circuitry operatively coupled to the position signal receiver, the signal-conditioning circuitry being adapted to receive the position signal from the position signal receiver and to convert the position signal into digitized position signal data; and

a personal computer card interface operatively coupled to the signal-conditioning circuitry, the personal computer card interface being adapted to  
15 provide an interface between the personal computer card and a host microprocessor system.

76. The personal computer card as set forth in Claim 75, wherein the portable computer card interface

STATEMENT UNDER ARTICLE 19

Pursuant to Article 19(1) of the Patent Cooperation Treaty, please amend claims 16 and 74.

Replacement pages 41, 42 and 66 are enclosed. These pages have been typed to include the amendments noted above.



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FIG. 1a

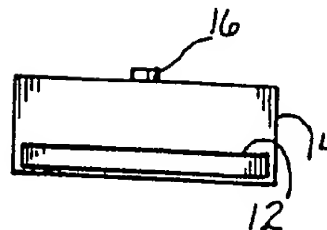


FIG. 1b

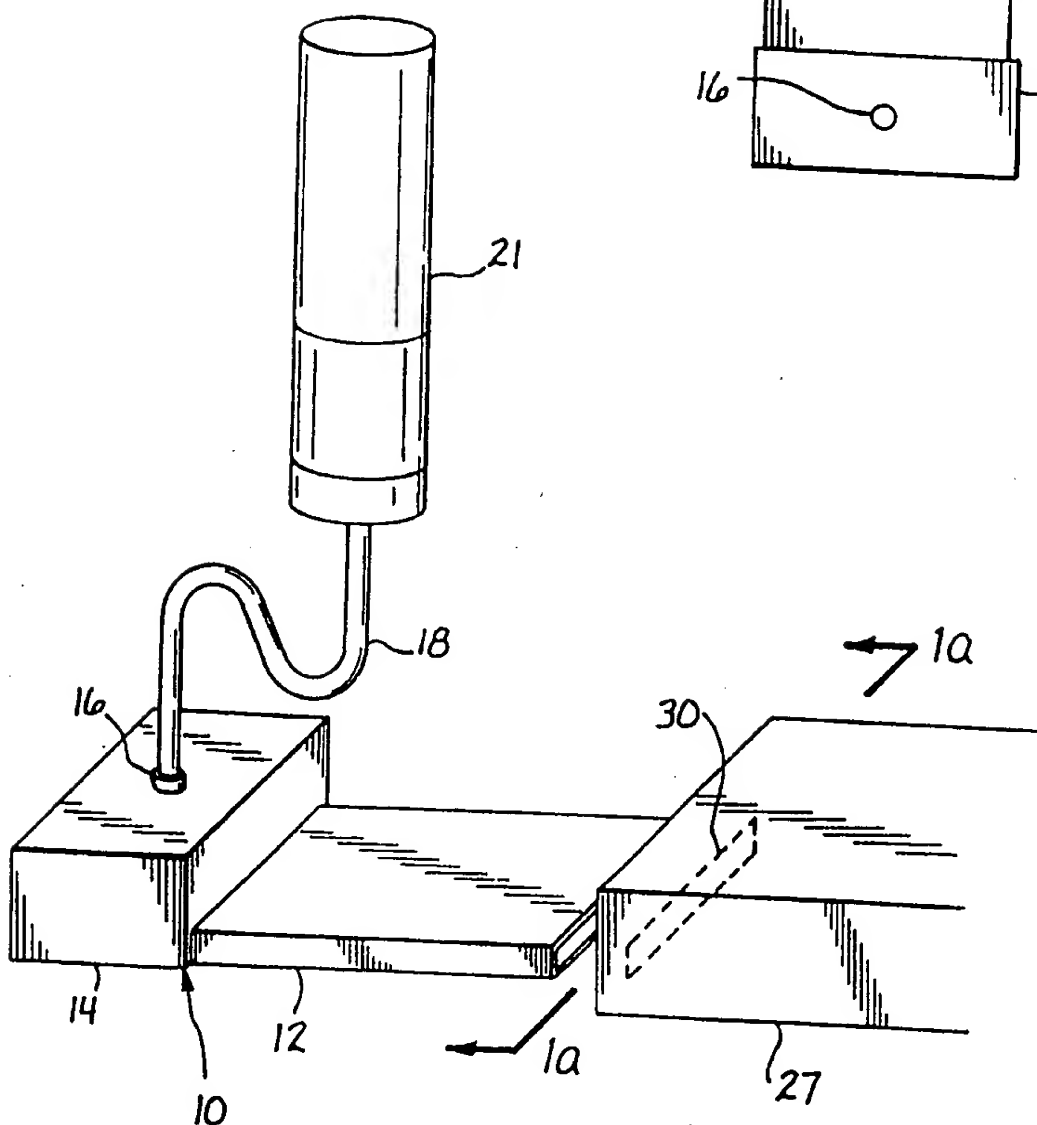
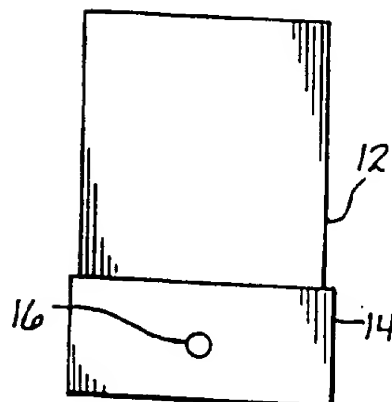


FIG. 1

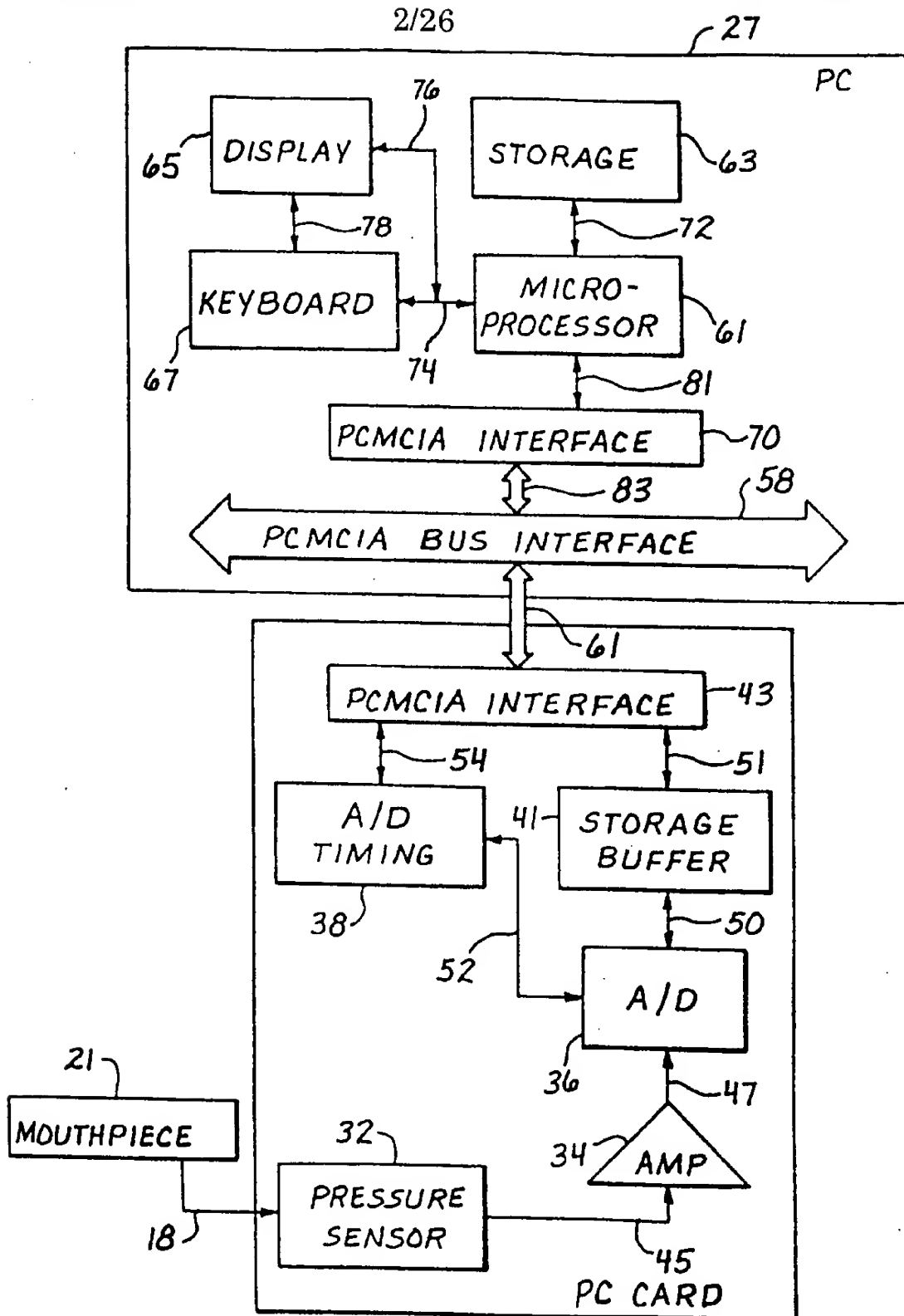


FIG. 2

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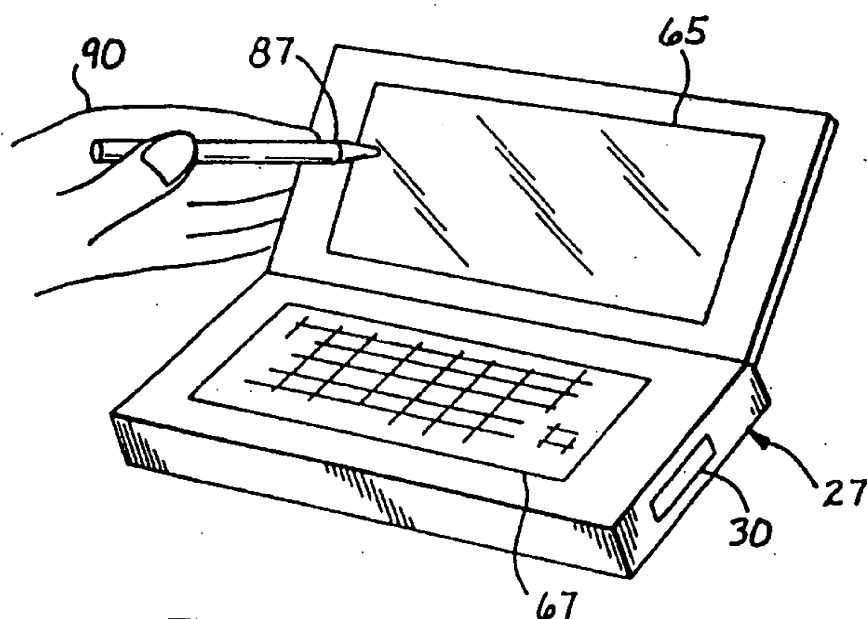


FIG. 3

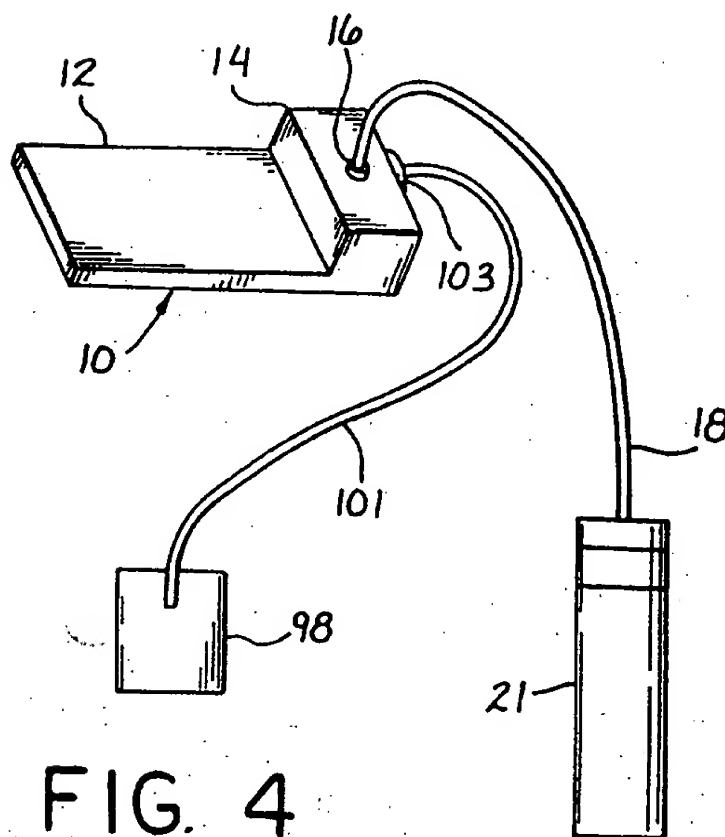


FIG. 4

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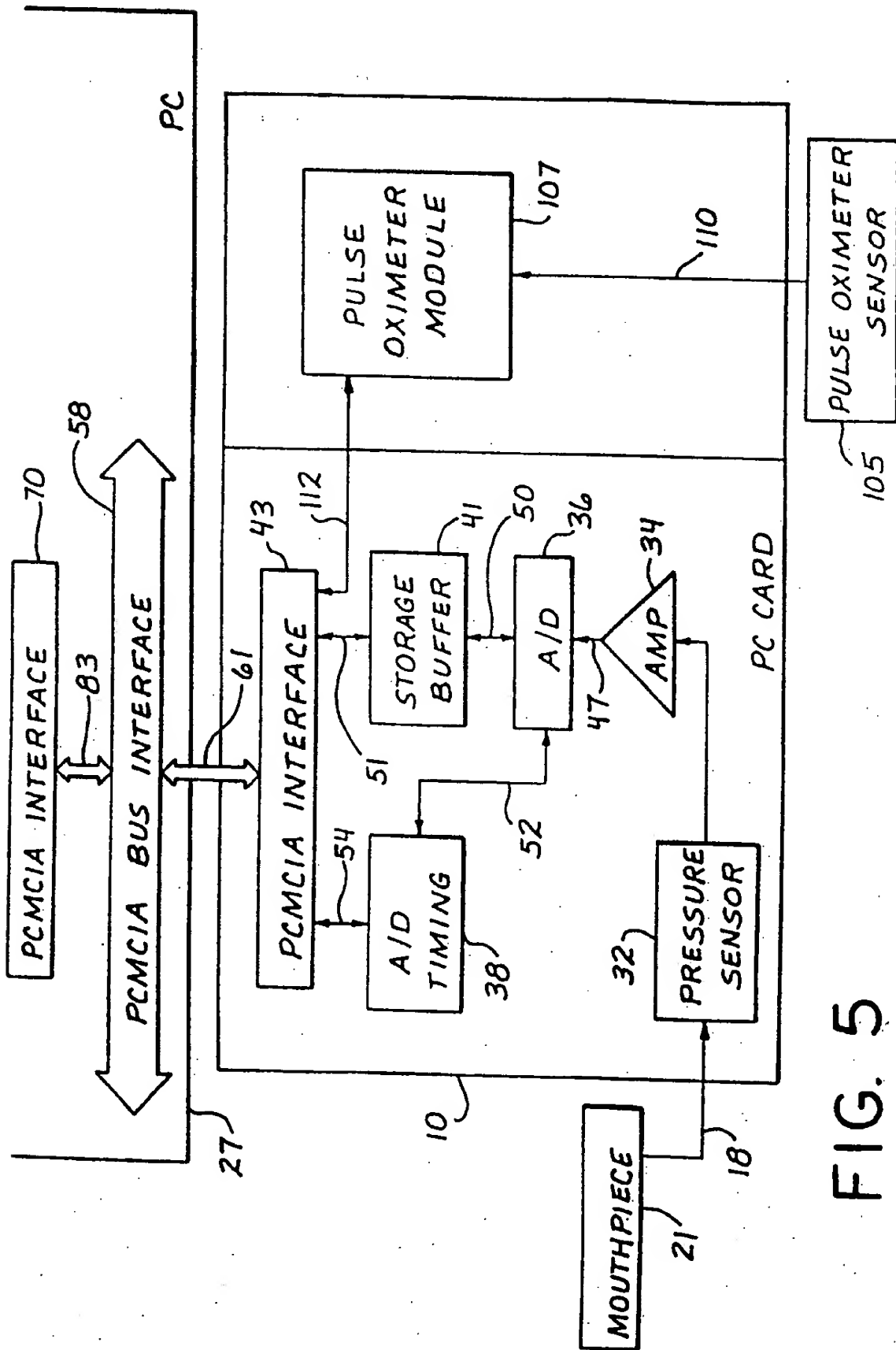


FIG. 5

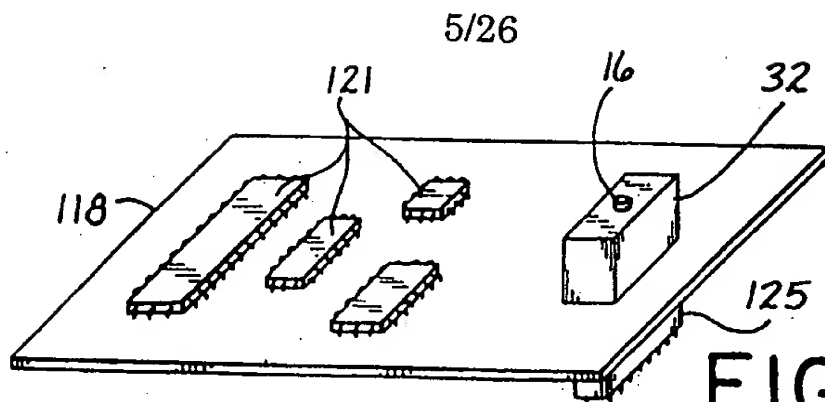


FIG. 6a

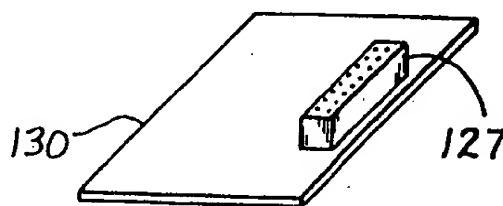
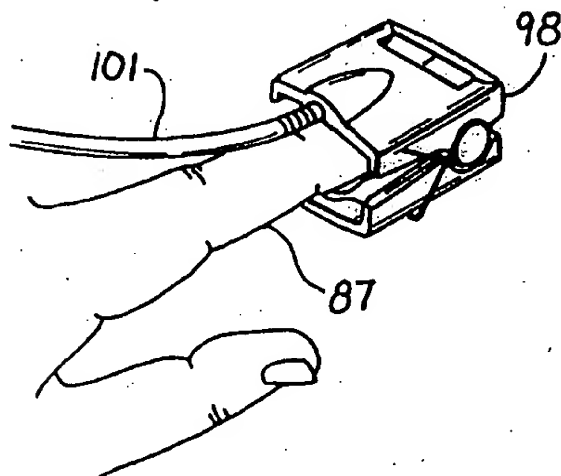
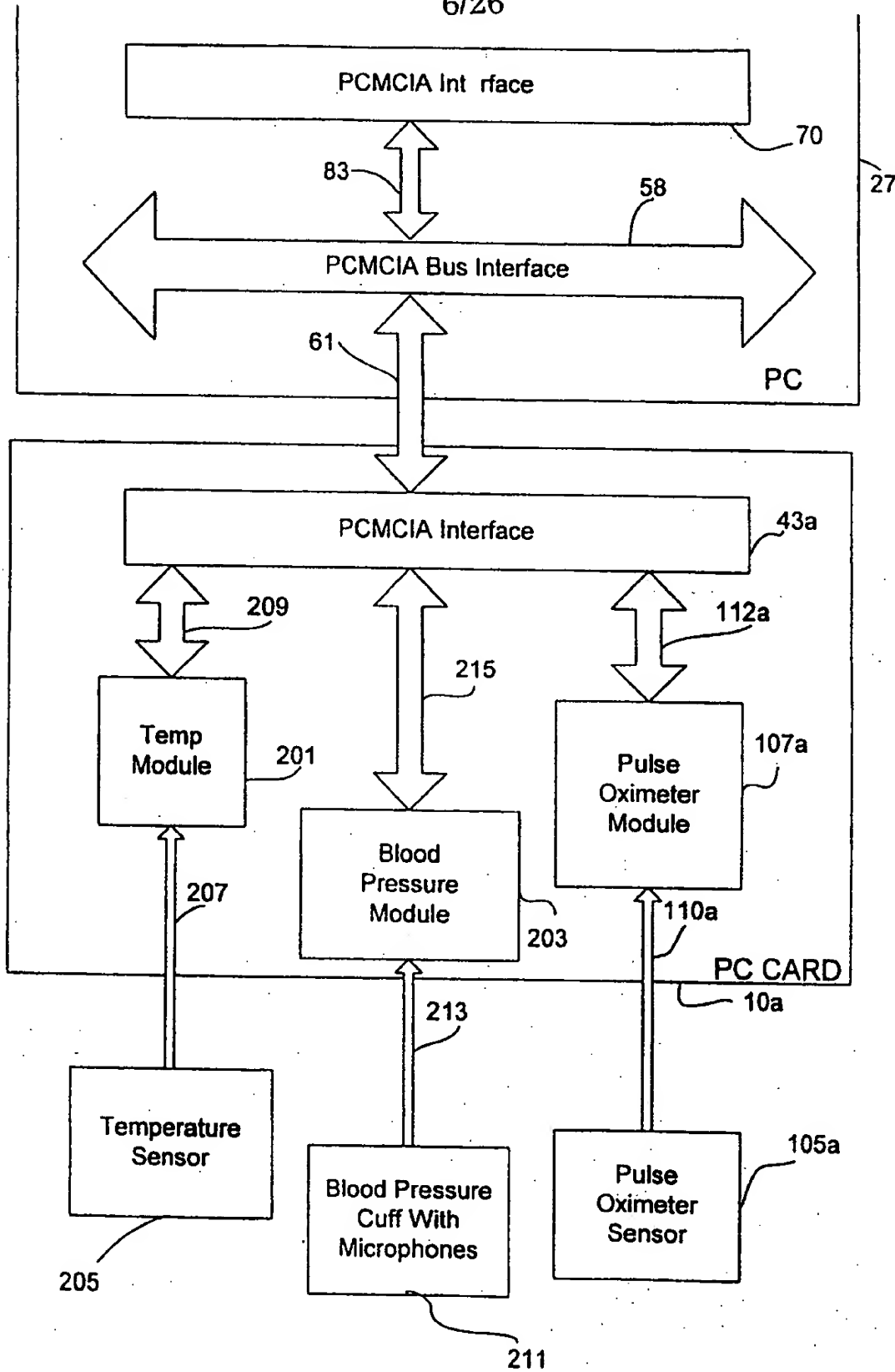


FIG. 6b

FIG. 7



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**Figure 8**

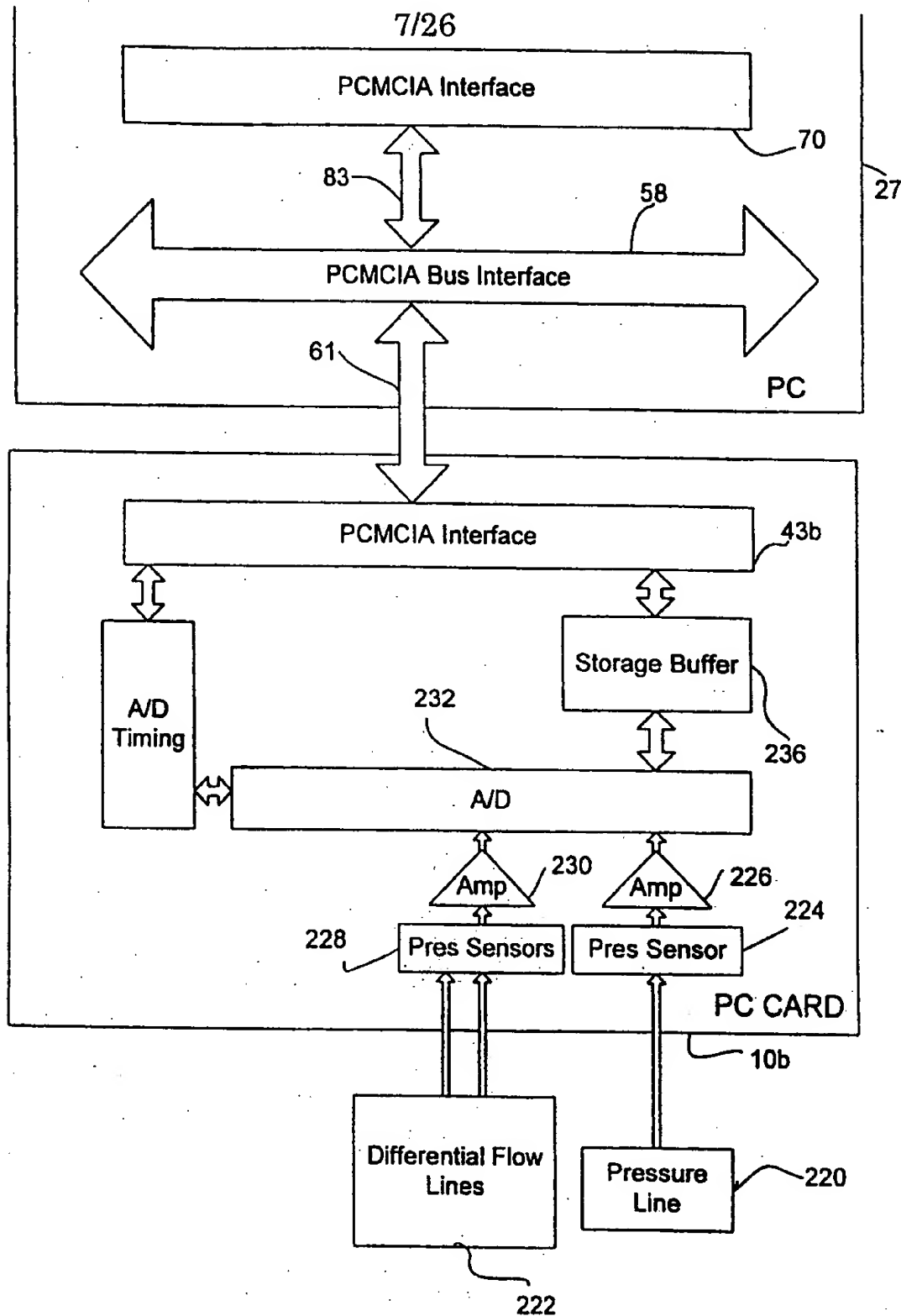
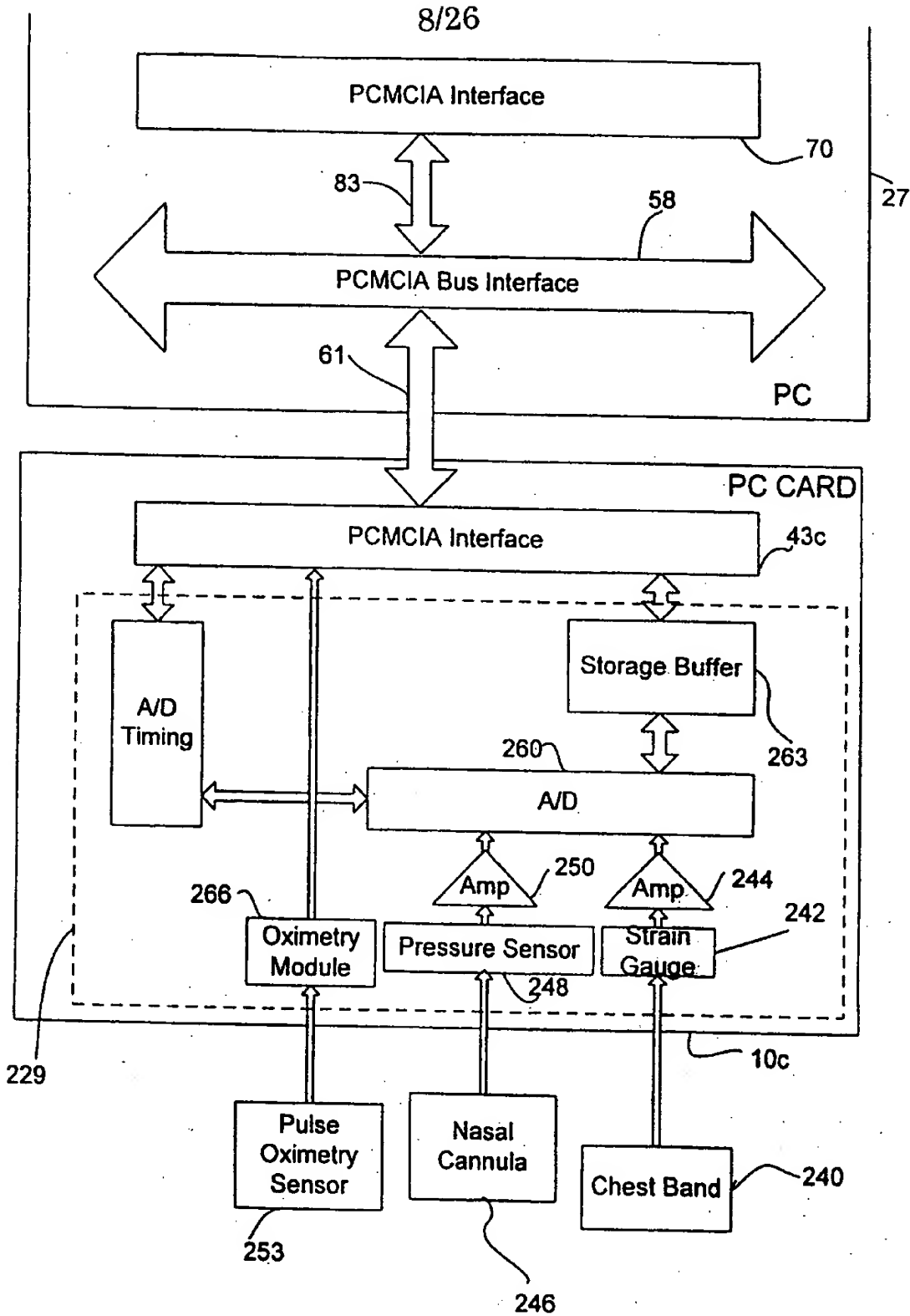


Figure 9



Figur 10



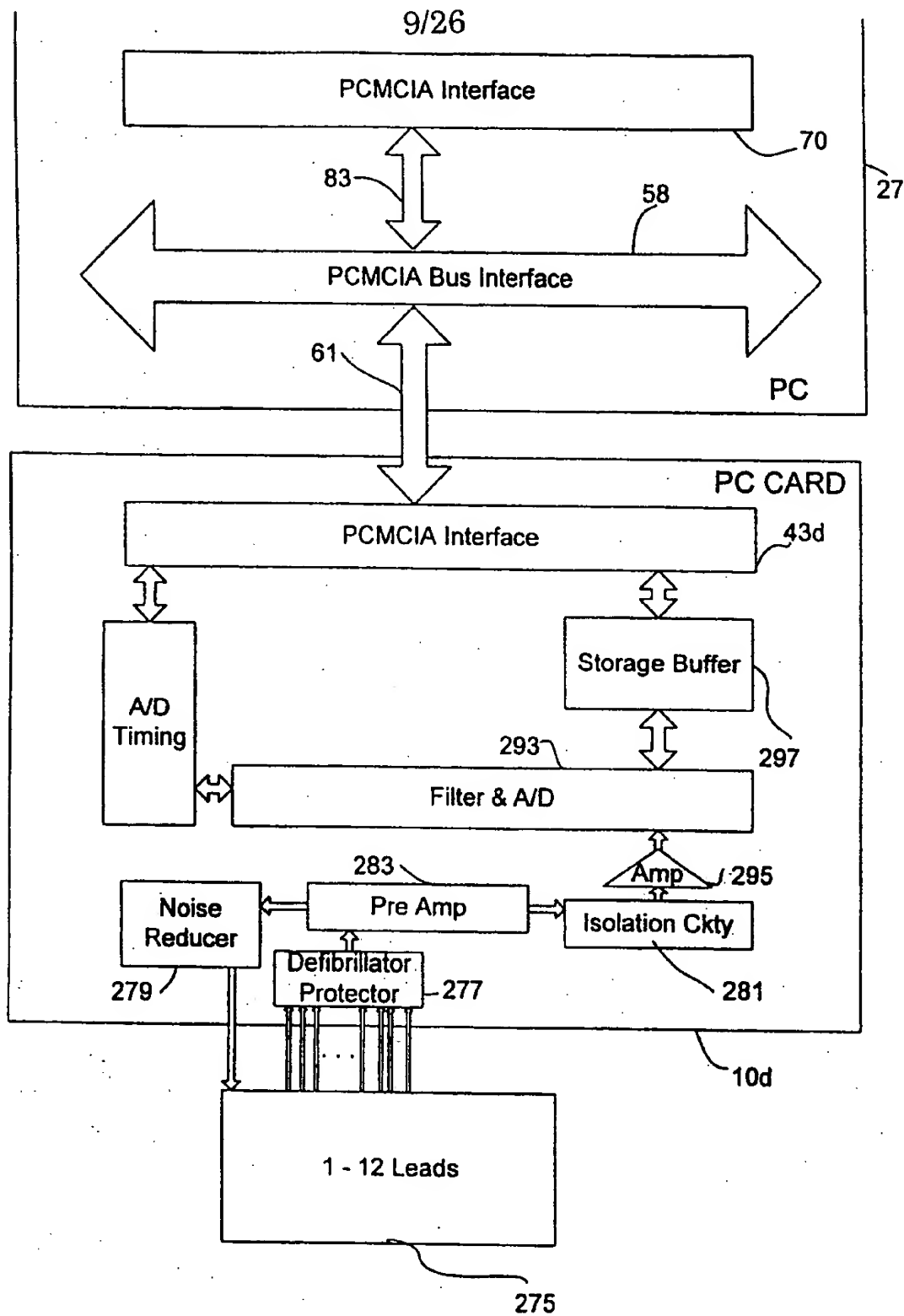
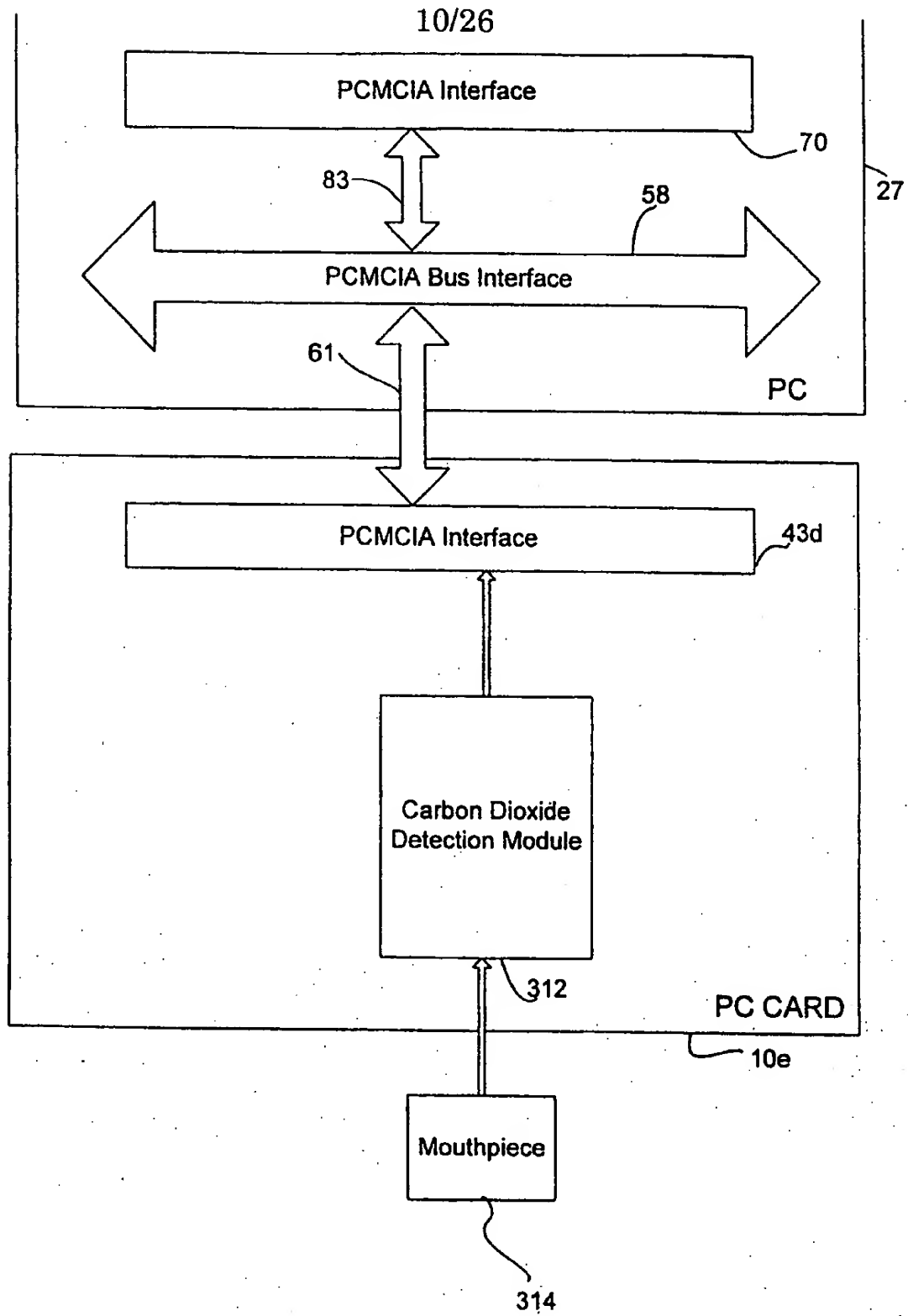


Figure 11

**Figure 12**

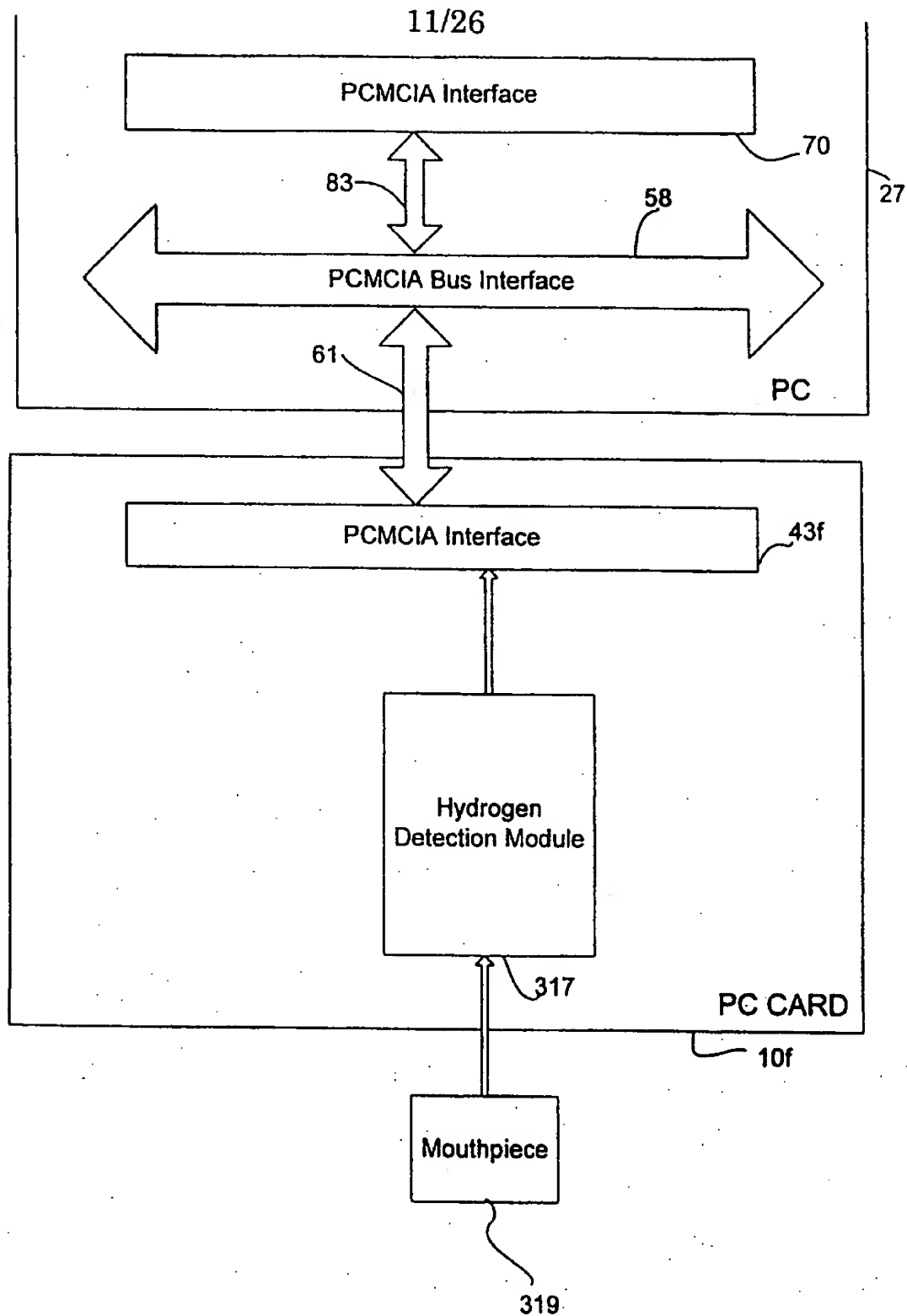


Figure 13

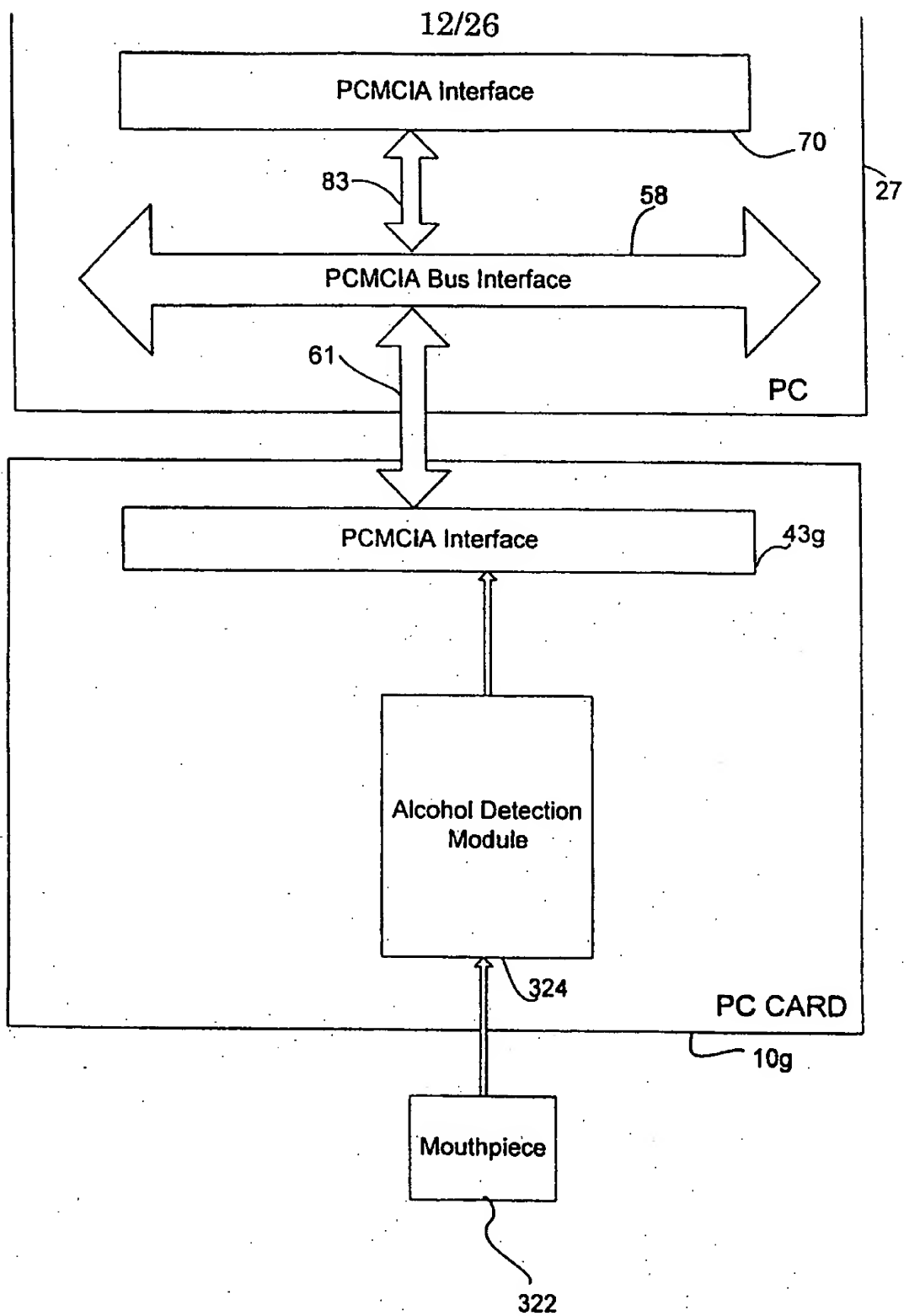
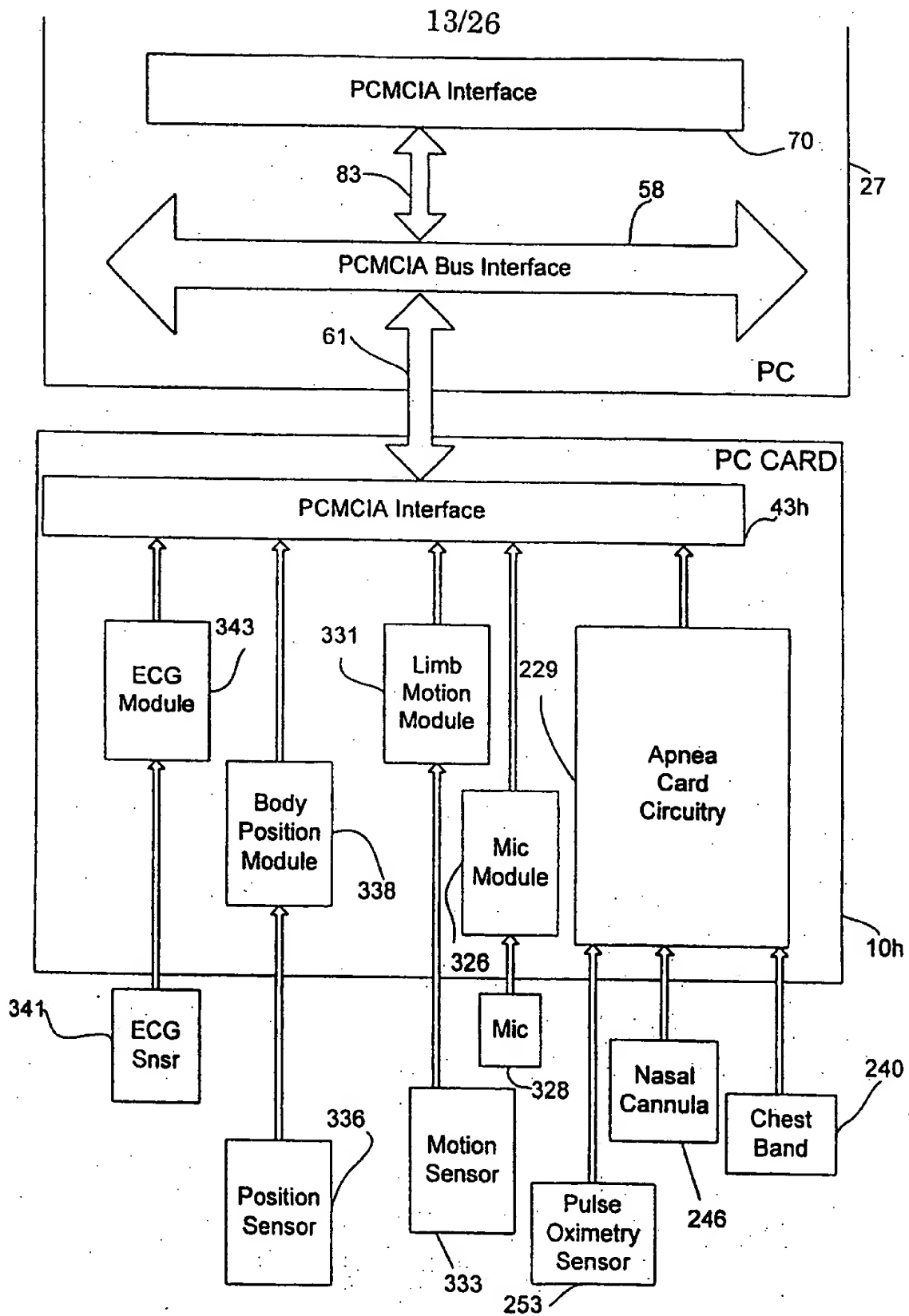
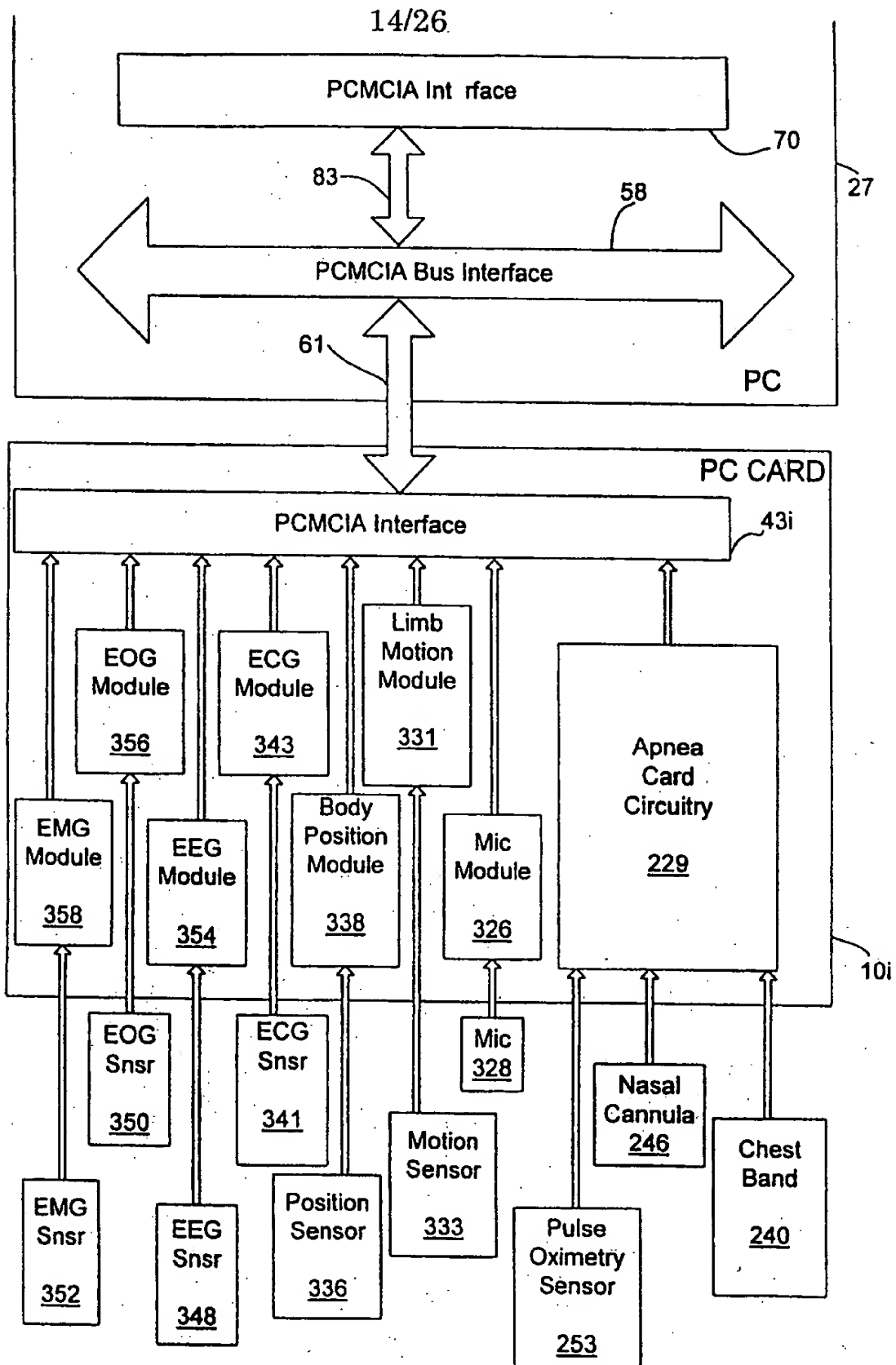
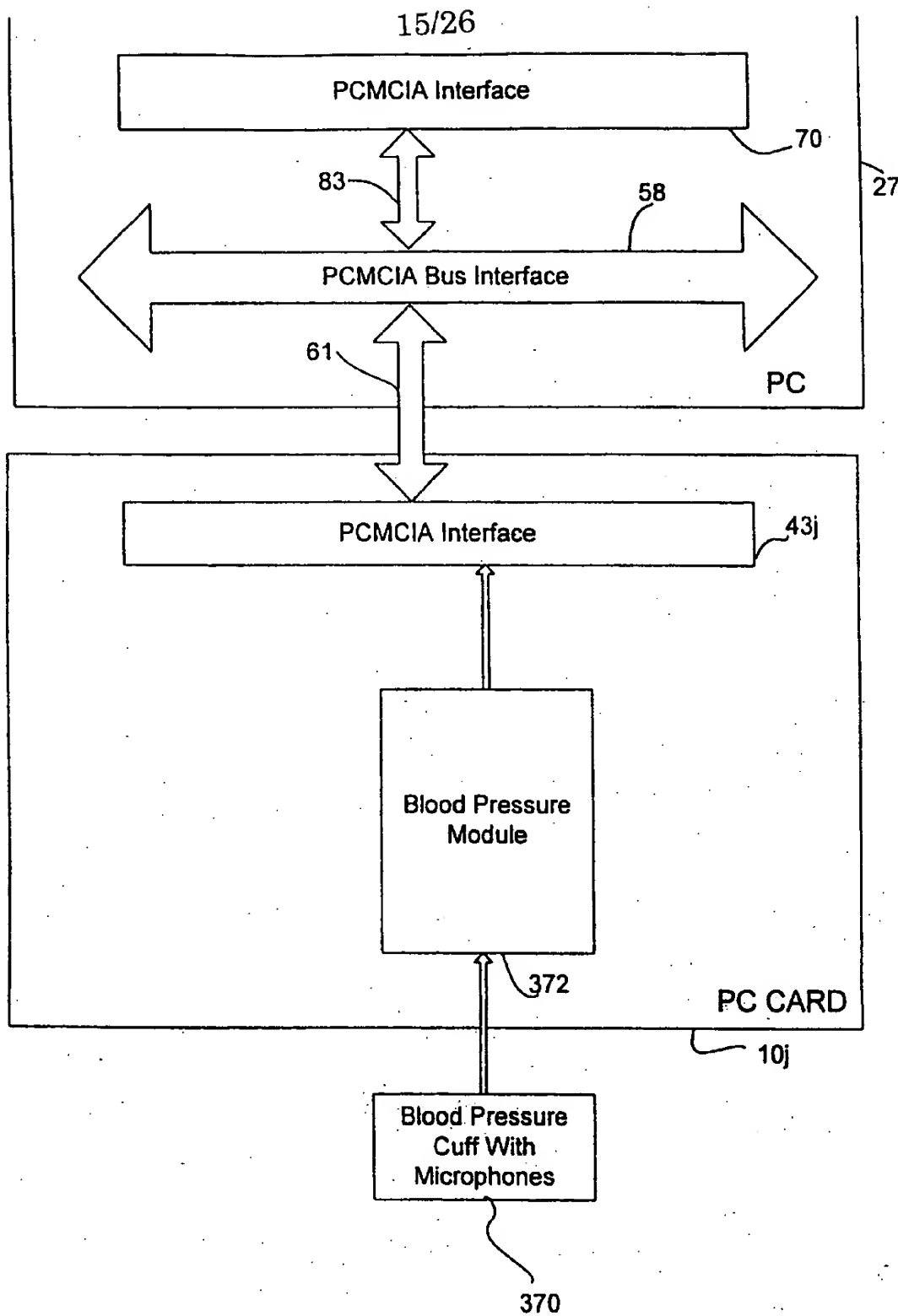


Figure 14

**Figure 15**



Figur 16

**Figure 17**

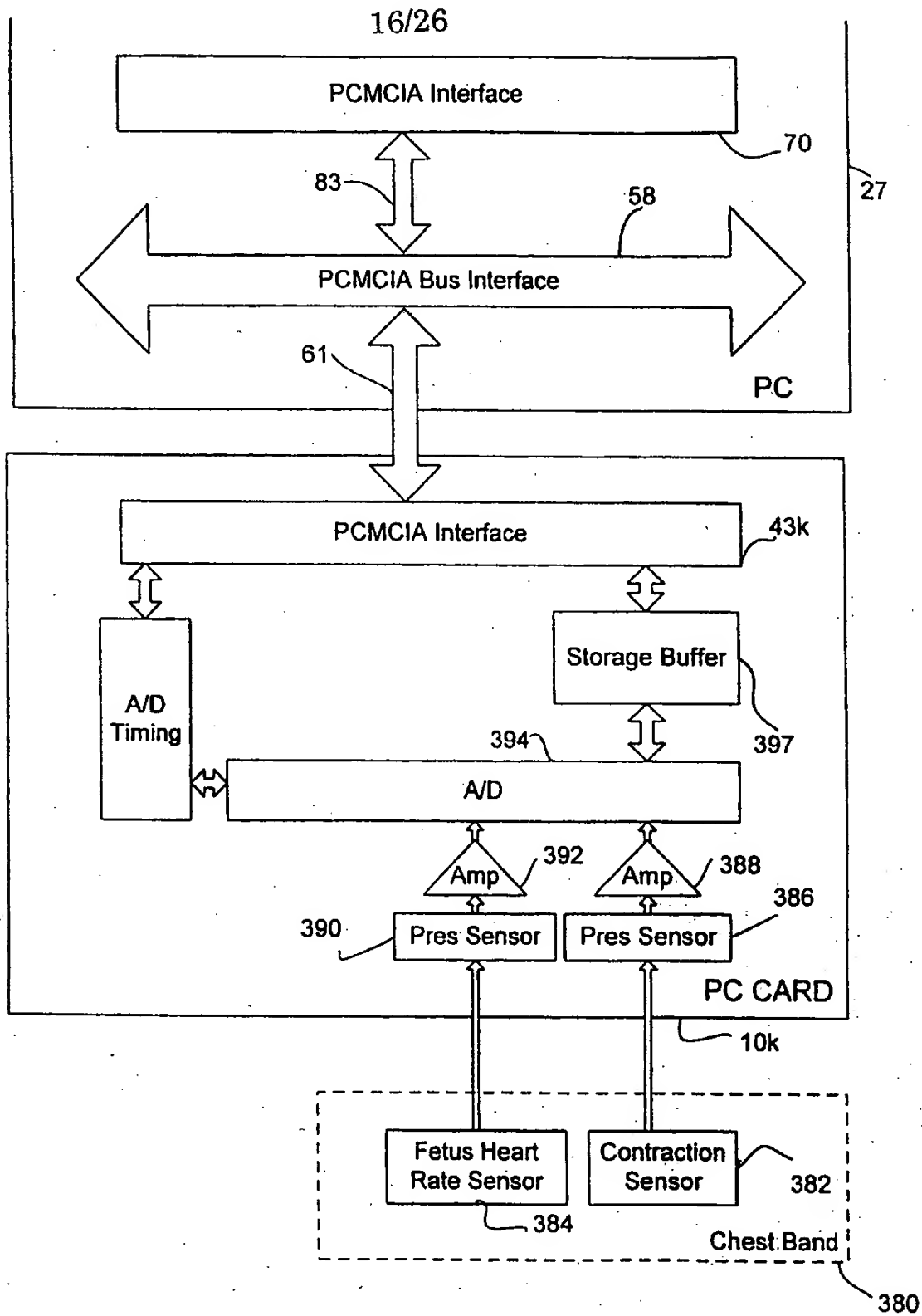


Figure 18



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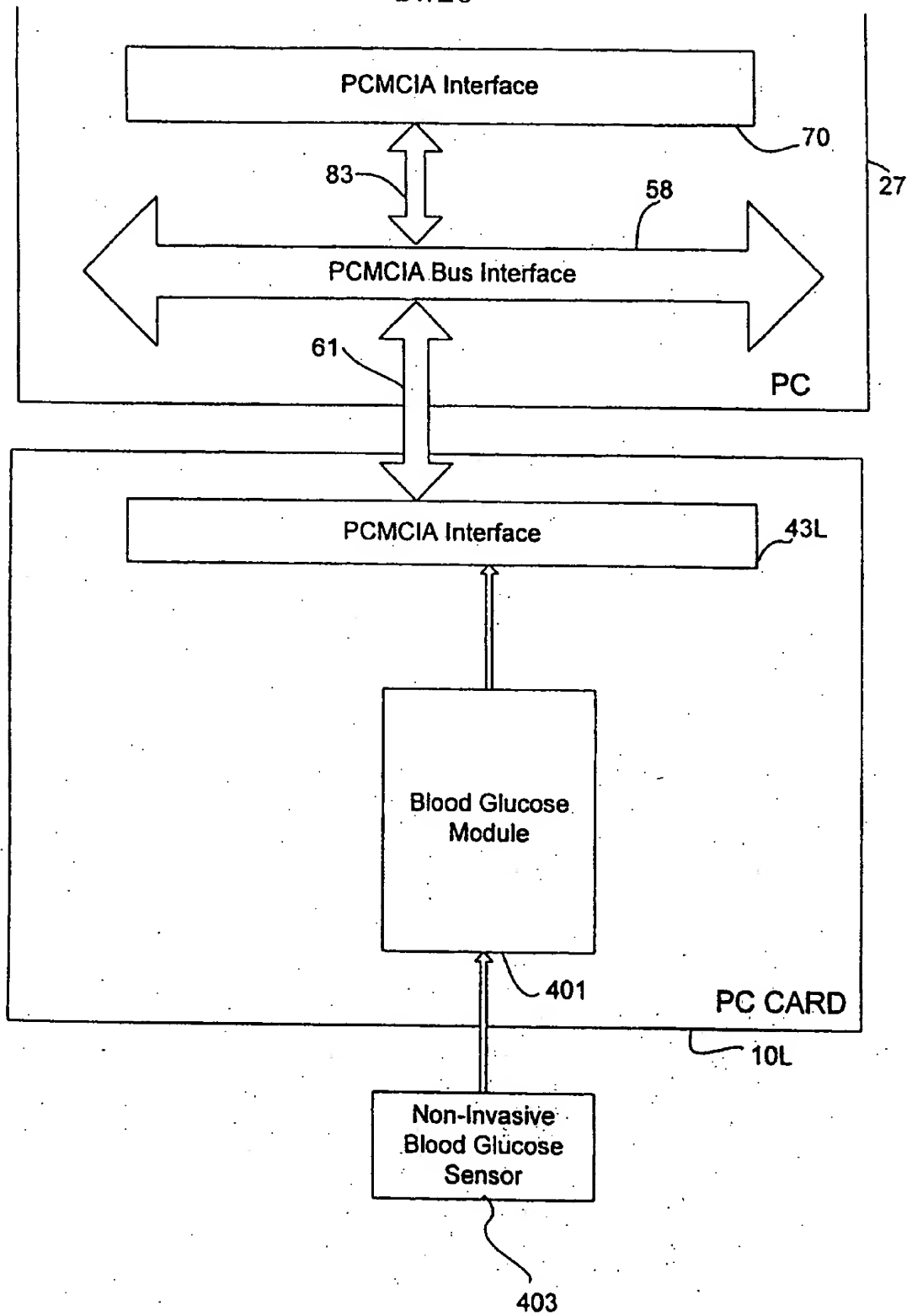
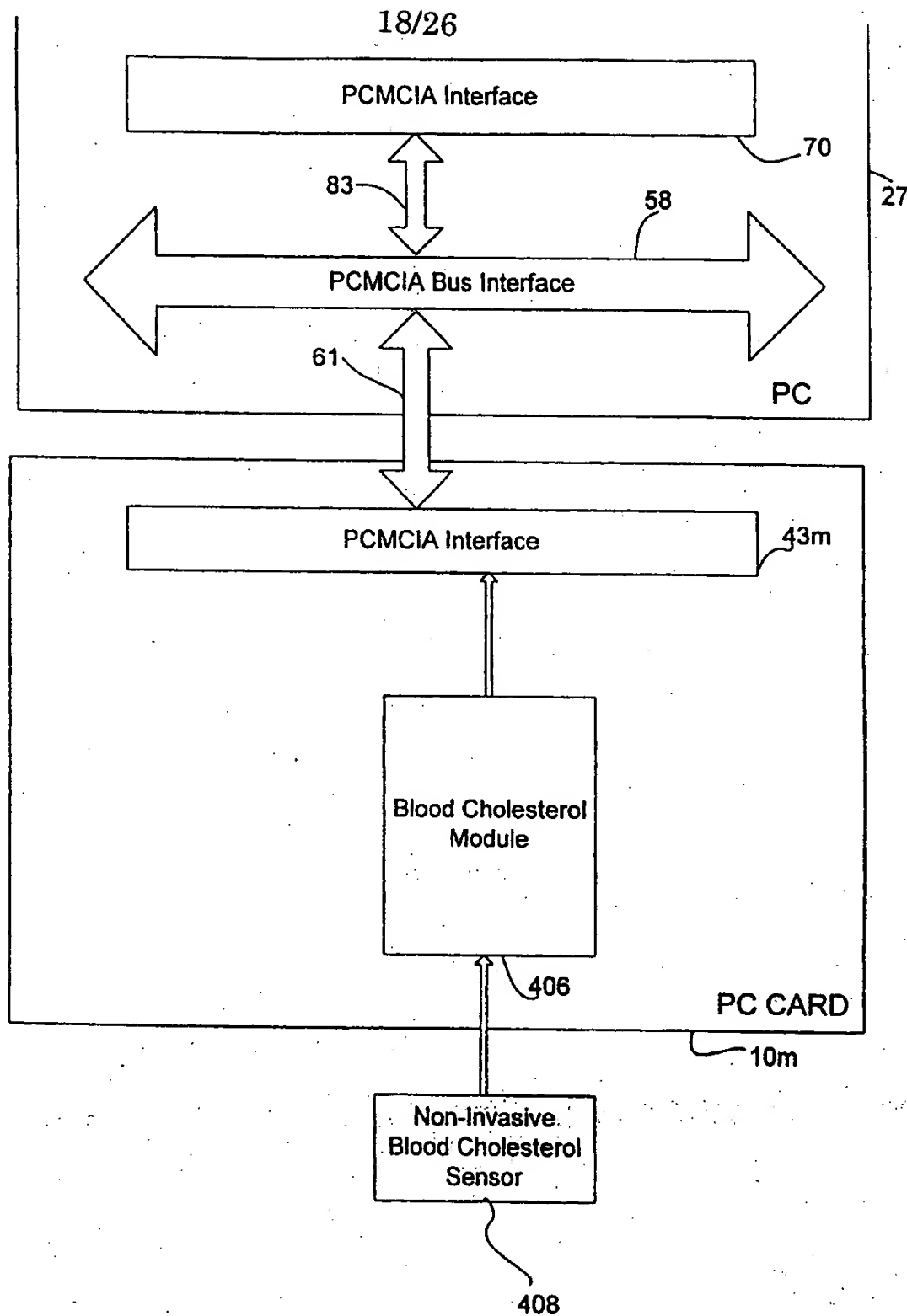
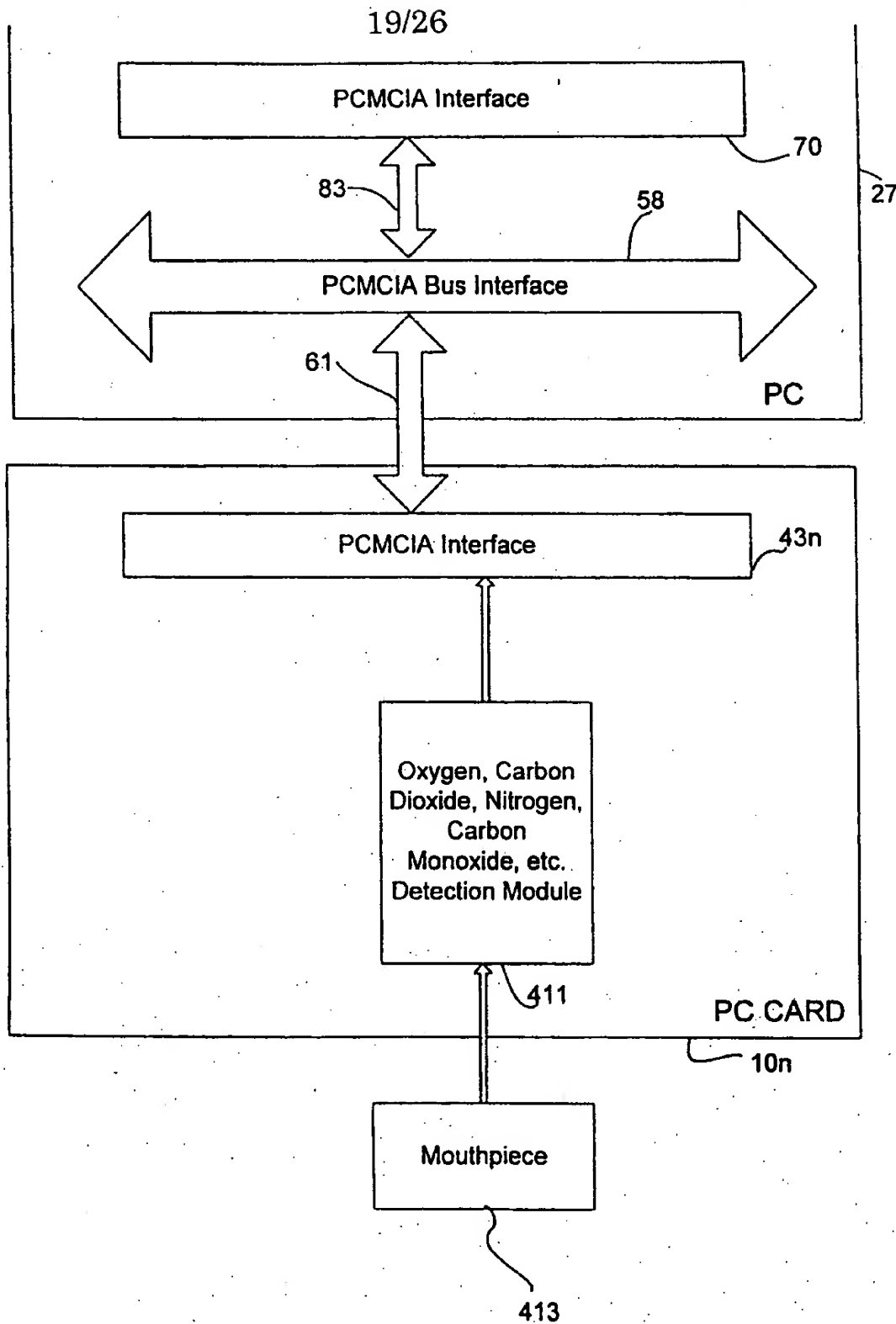
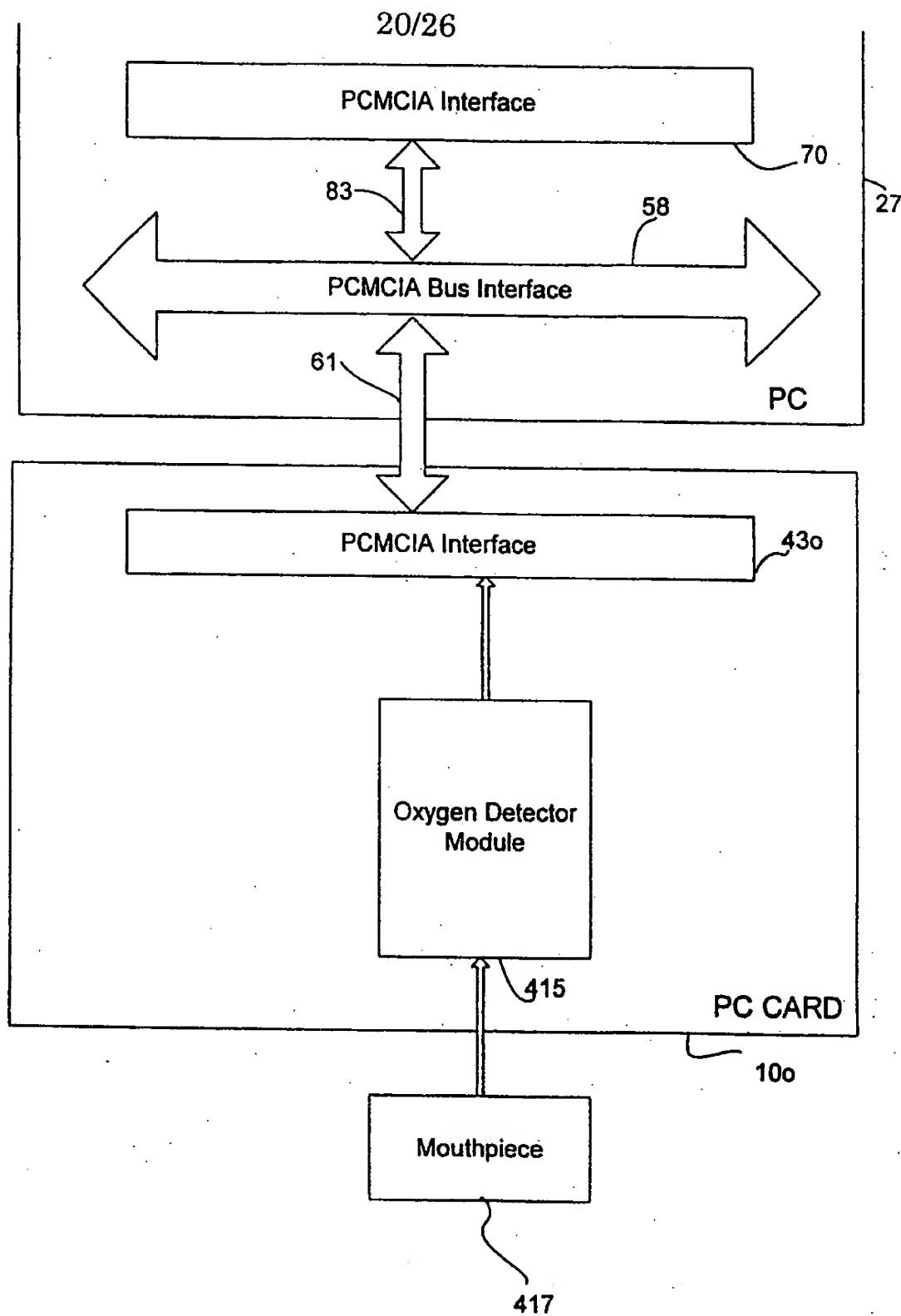


Figure 19

**Figure 20**

**Figure 21**

**Figure 22**

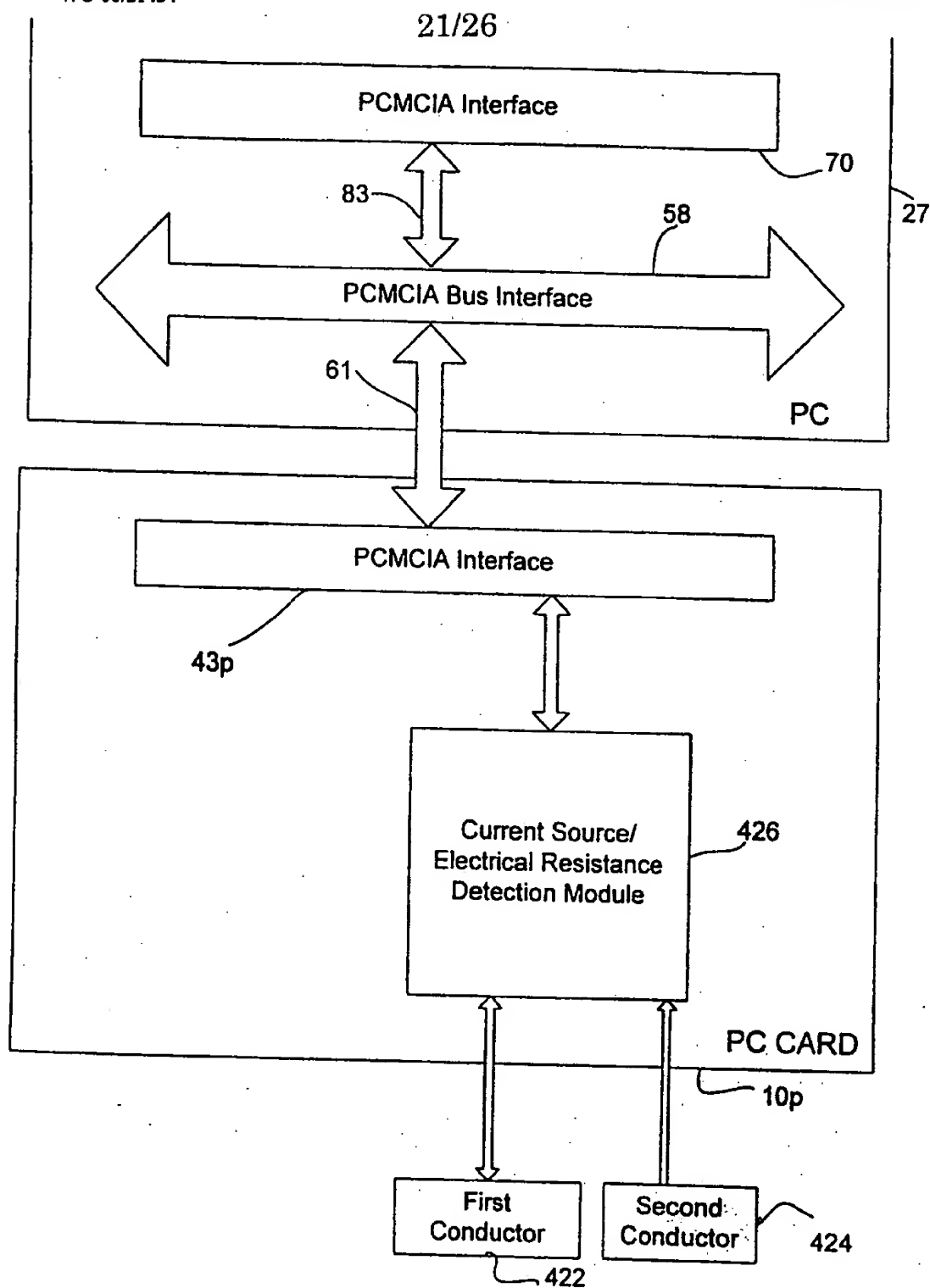


Figure 23

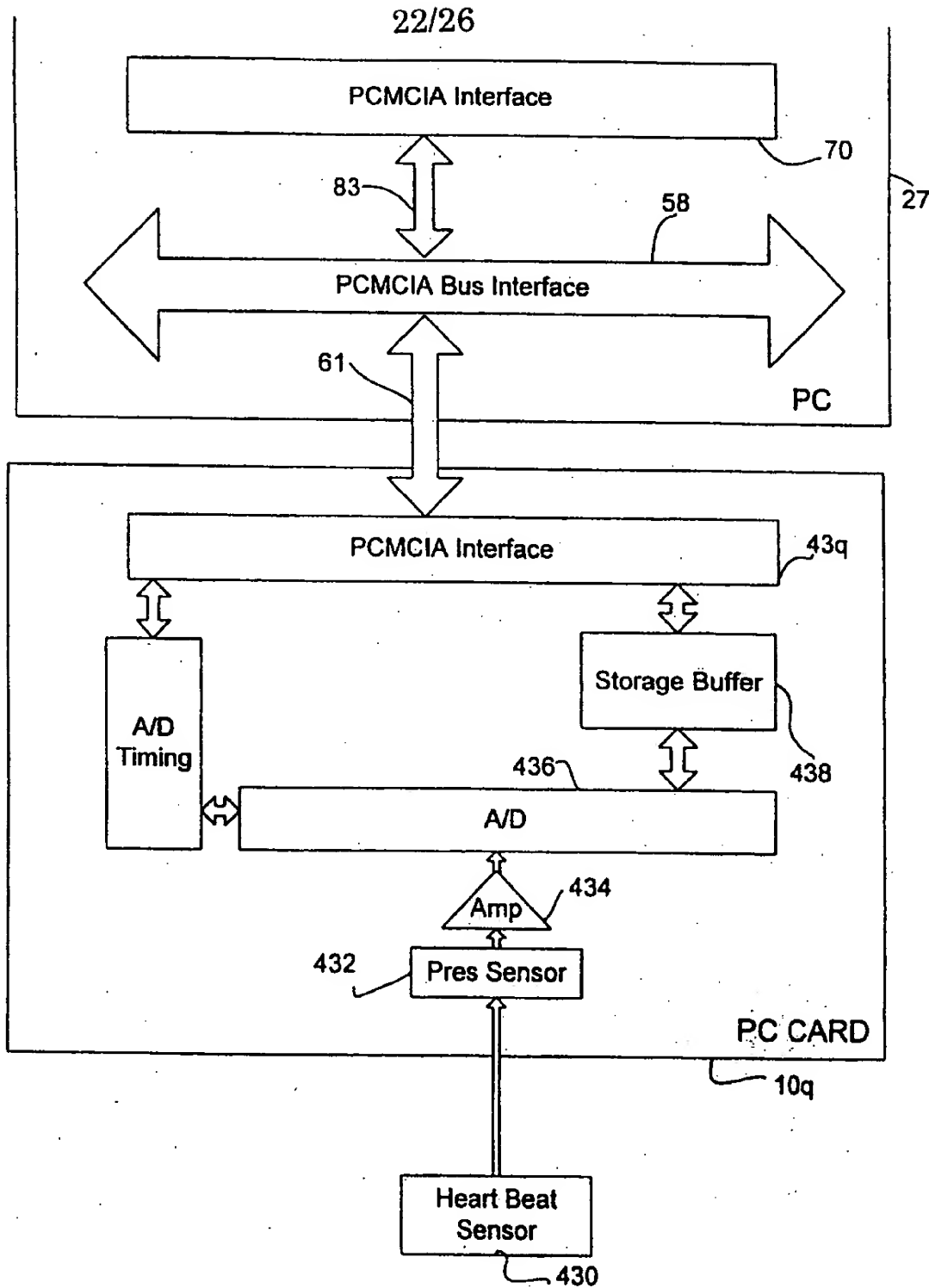
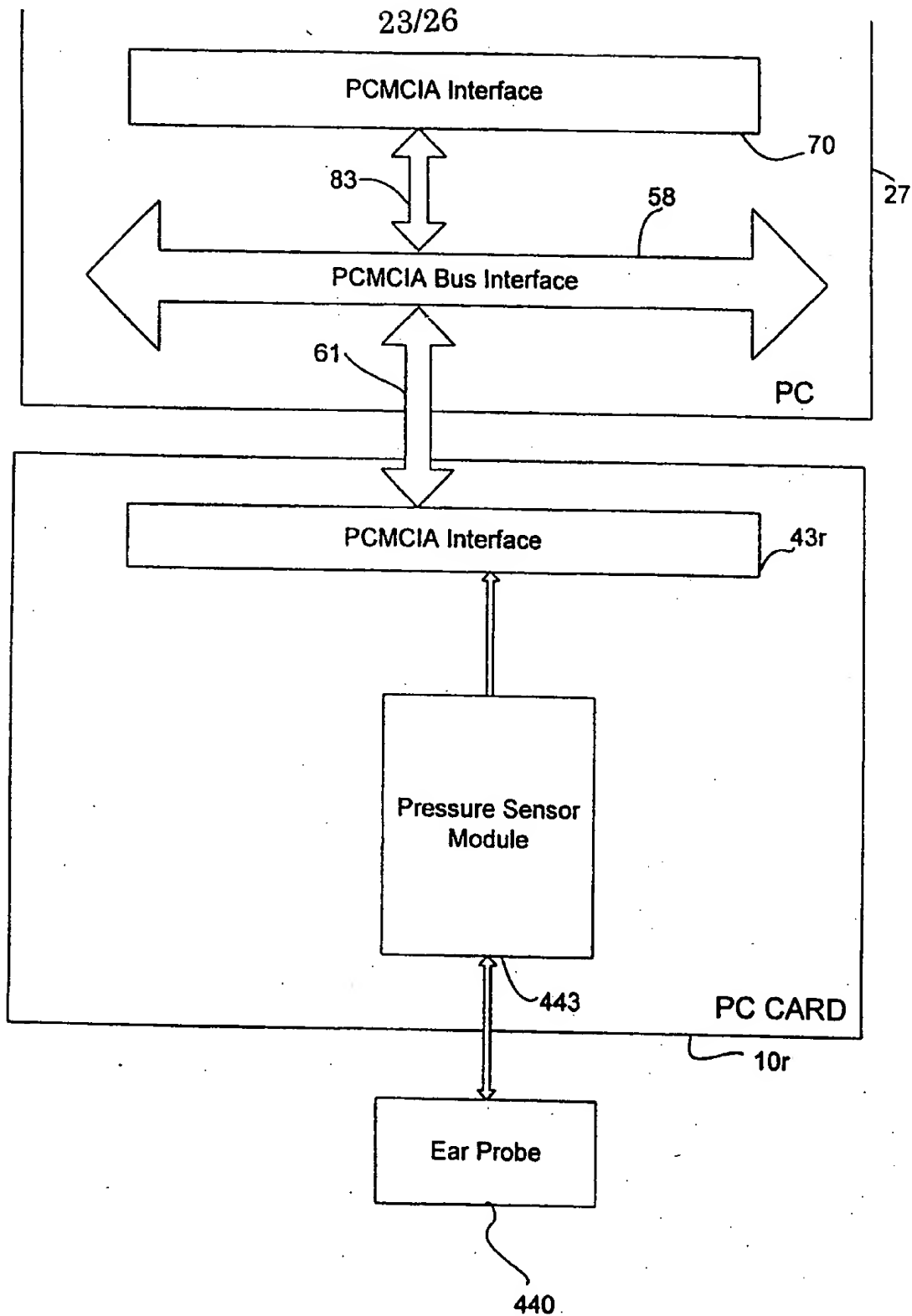
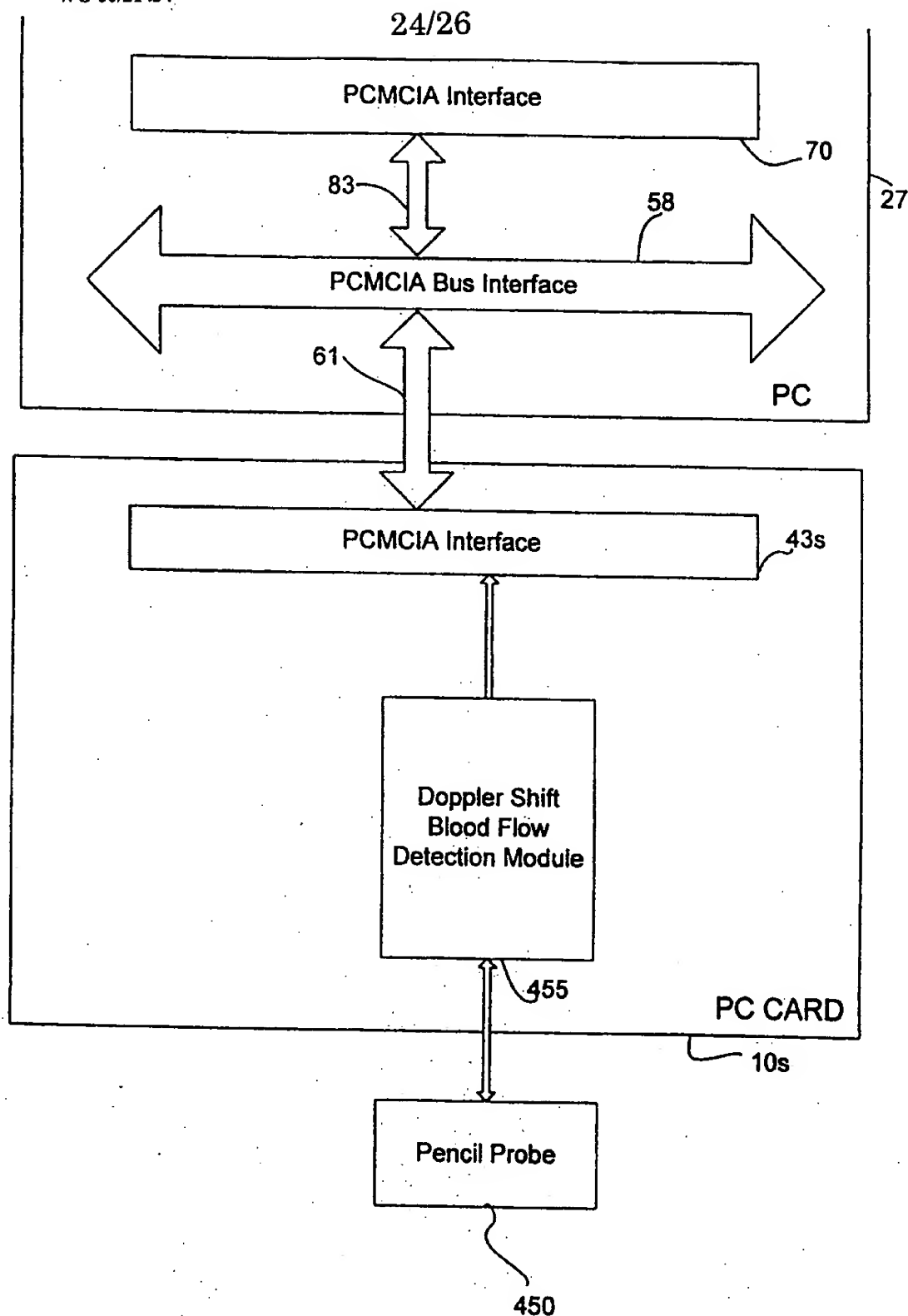


Figure 24

**Figure 25**

**Figure 26**



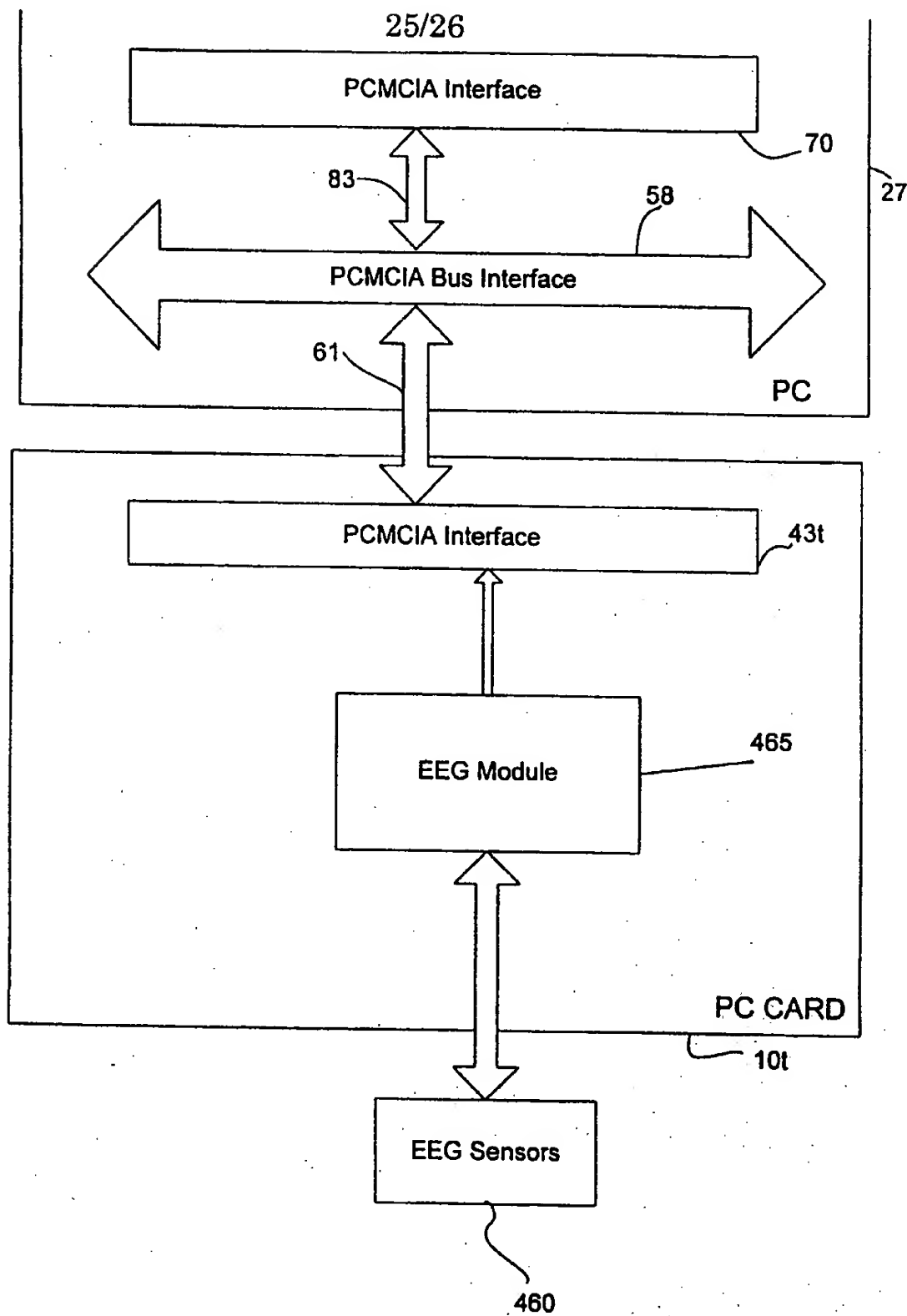


Figure 27

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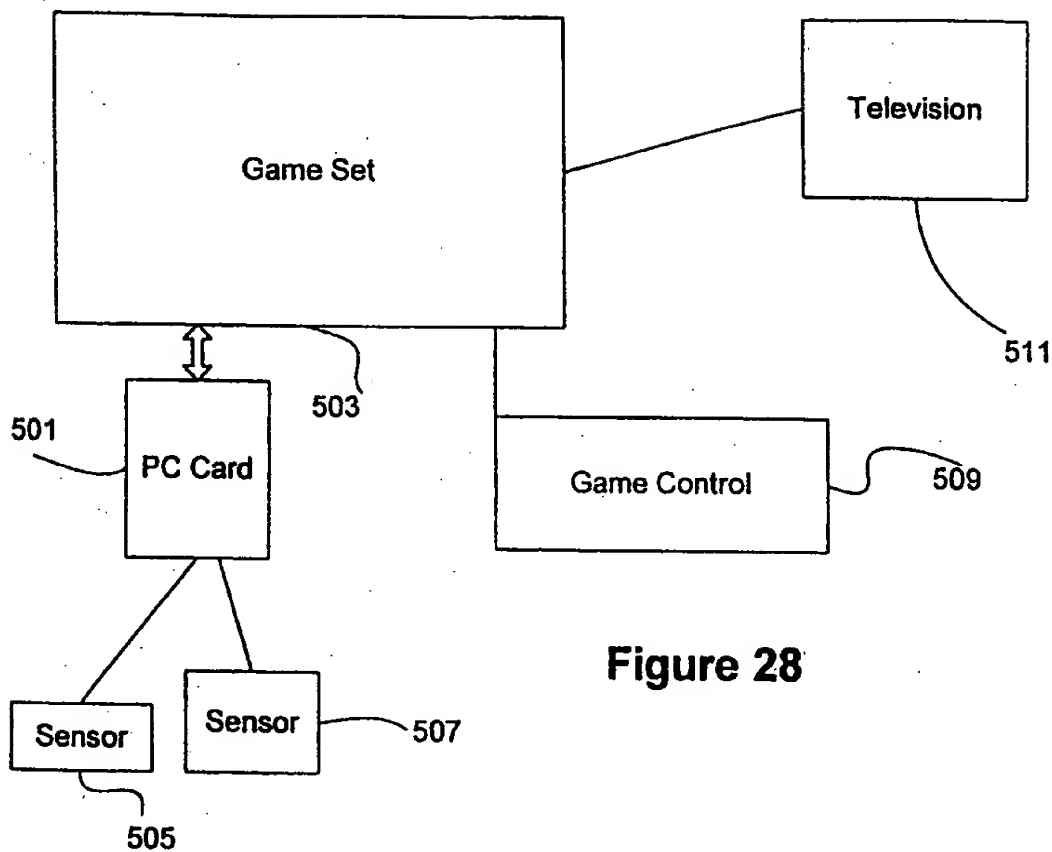


Figure 28

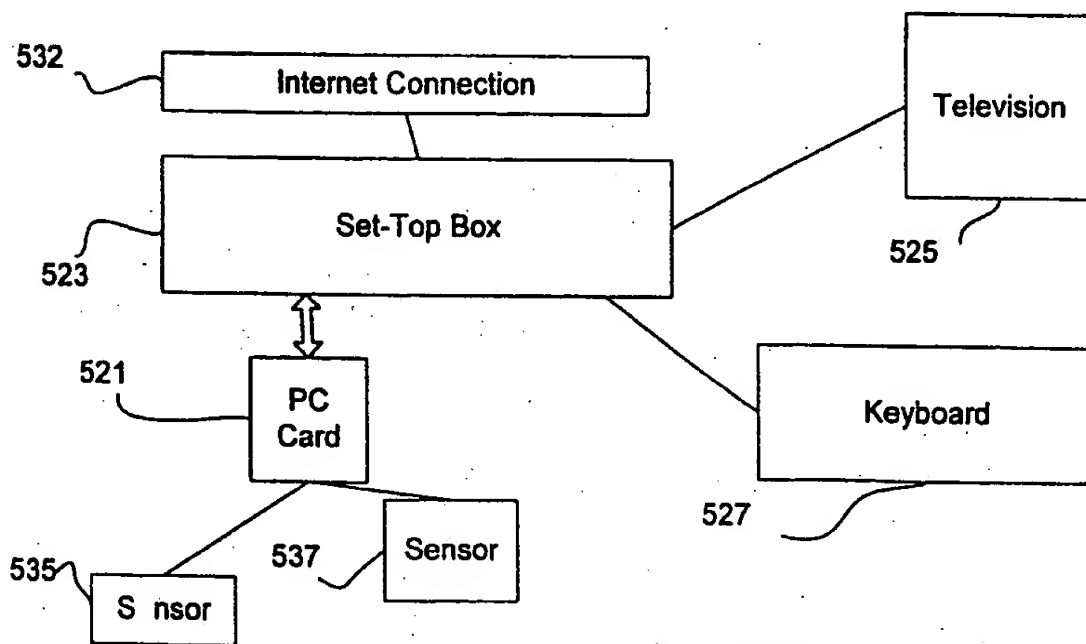


Figure 29

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/22644

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A61B 5/00

US CL :600/300

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 128/920; 600/300, 301, 309, 323, 364, 481, 508, 537, 538, 544, 546, 549

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,307,263 A (BROWN) 26 April 1994, entire document.	1, 3
X	US 5,701,894 A (CHERRY et al.) 30 December 1997, entire document.	1

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Z" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

13 DECEMBER 1999

Date of mailing of the international search report

27 JAN 2000

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